Proposal for an Associate in Applied Science in Applied Science and Engineering Technology Program

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I. Abstract

This proposed program will give students the opportunity to earn an Associate in Applied Science (AAS) Degree in Applied Science and Engineering Technology. The program provides a flexible curriculum designed to prepare students for employment as skilled technicians in science and technology growth areas, many of which are interdisciplinary in nature. While providing students with essential science background knowledge, the program will also prepare them for positions that range from research and development technicians to production and manufacturing technicians in areas such as process technology, nanotechnology and biotechnology. There are also numerous opportunities for students to continue their education in four-year technology-based programs. With large current and projected workforce needs in scientific technology areas, and an insufficient number of students currently in the regional pipelines to fill these needs, the proposed program will make Community College of Philadelphia uniquely positioned to help support the economic health and address the workforce needs of the region, while providing enhanced opportunity for our students.

Special features of the program include:

- Rapid response to changing opportunities in the workforce
- Multiple entry and exit points for students
- A curriculum that addresses needs that transcend a wide range of scientific technology areas
- Focused course clusters organized into certificates that can be offered to individual students as well as to corporate clients seeking specialized programs for their employees

This proposed AAS degree program provides a curricular infrastructure consisting of a small number of specific course requirements, and a large number of directed electives. A new category of courses, Applied Science, is proposed. A subset of Science courses, Applied Science courses place more emphasis on the application of scientific principles to the solutions of real world problems than traditional science courses do. Sets of specialized courses that prepare students for employment in a particular area can be clustered together and offered as "certificates of completion." Students could complete the course clusters separately and go directly into the workforce, or complete them while pursuing their AAS degree. Students who complete a certificate program separately could later decide to continue their education, and the credits they earned for the certificate would count toward their AAS degree. Upon completion of the AAS degree program, students would be able to enter the workforce directly, and would also have the option of pursuing a baccalaureate technology degree, either immediately or after employment in the field for some time.

The proposed program structure has the added advantage that the College would be able to respond more quickly to changing workforce needs by adding new certificate of completion programs, or by phasing out existing ones, as industry and student demands change.

The proposal has been positively received by representatives of various industries and organizations, including Sunoco, The Life Science Career Alliance, The Collegiate Consortium,

Delaware Valley Industrial Resource Center, The Science Center, and Wistar Institute. Industry feedback has, in turn, helped strengthen this proposal.

II. Opportunities Addressed by the Associate in Applied Science and Engineering Technology Program

This program is designed to provide opportunities for students interested in scientific technology, and at the same time address workforce and economic development demands in the region. As described in the Occupational Outlook Handbook, "Science technicians use the principles and theories of science and mathematics to solve problems in research and development and to help invent and improve products and process." (The full description of science technicians from the Occupational Outlook Handbook is included in Appendix A).

Adapting Educational Programs to Changing Technology

Continual advances in science and technology have resulted in a lag in workforce development and industry's consequent need for qualified staff. The challenge for industry has been to find a workforce well versed in the latest technologies, yet adaptable to future technological advances; the challenge for the student has been to acquire a diverse range of appropriate knowledge, but also master the skills required to gain employment. It is the challenge of educational institutions to be responsive to the needs of both industry and students.

In technical fields there is an ongoing tension between what may be termed education and what may be termed training. In this context, the term *education* is used to mean teaching of broad based principles, good problem solving skills, and the ability to learn and adapt to change. *Training* is used to refer to specific "how-to" information, related to particular technologies. Too often, the result of the tension between education and training has been either to provide students with a broad general knowledge in science and math, but with too few skills to quickly and smoothly enter the workforce (leaving the specific training to industry), or to give students very specific and targeted training to help them get into the job market quickly and meet short-term industry needs, but limiting their ability to grow professionally as industry continues to evolve. The proposed AAS degree program seeks an appropriate balance between education and training, by ensuring that students have a strong science foundation, that they receive training applicable to industry need, and that the scientific and technical underpinnings of job-related skills are addressed.

The proposed Applied Science and Engineering Technology Program is designed to allow the College to respond rapidly to shifting workforce needs by providing a curricular structure that is highly adaptable. Students can meet graduation requirements by selecting from a wide range of science and applied science courses. In cases where a particular workforce need is identified, a set of courses can be clustered and offered as a certificate of completion. The certificate of completion can be offered as a stand-alone cluster of courses, for example, to incumbent workers and students who have already earned a degree, thus providing advancement or direct entry into the workforce. The courses that make up the certificates of completion could also be applied to the proposed AAS degree program, thus providing students with seamless multiple entry and exit points in the program.

When a new workforce need is identified, it will be possible to identify a new cluster of courses (which is likely to include development of one or more new courses). The new cluster can then be offered to students as a new certificate of completion and marketed both to employment and degree-seeking students and to industry to provide continuing education for their existing workforce.

Federal and State Focus on High Demand Employment Areas

Federal and state funding agencies are increasingly focusing their efforts on the links between workforce development, economic development, and the alignment of educational programs with industry needs. In an effort to address this issue, the Federal government has established the High Growth Job Training Initiative (HGJT) "to prepare workers for new and increasing job opportunities in high growth and economically vital industries and sectors of the American economy. The initiative is designed to provide national leadership for a demand-driven workforce system by identifying high growth/high demand industries, evaluating their skills needs, and funding demonstration projects that provide workforce solutions to ensure individuals can gain the skills to get good jobs in these rapidly expanding or transforming industries." ("The Biotechnology Industry, Identifying and Addressing Workforce Challenges in an Emerging Industry," Prepared by New Economy Strategies, LLC and the Leonard Resource Group, Inc. for the U.S. Department of Labor Employment and Training Administration Business Relations Group, October 2004)

The High Growth Job Training Initiative identified twelve industries as high demand areas, several of which will be addressed by the proposed AAS in Applied Science and Engineering Technology curriculum. Biotechnology and advanced manufacturing are among the twelve industries that have been targeted by the HGJT Initiative.

For example, the United States Department of Labor (DOL) recently awarded a $5.1 million grant to the Delaware Valley Innovation Network (DVIN), a tri-state, thirteen county collaborative effort that has, as one of its goals, "To support and strengthen the education and training structure (K-adult continuing education) to address the current and emerging needs of the life science industry." (from DVIN literature) A related $1.5 million DOL grant was recently awarded to the Life Science Career Alliance (LSCA) to support the Biotechnology Human Capital Investment Project (Biotech Project) to bring together members of the biotechnology industry and community colleges in the Delaware Valley to create educational programs that will provide students with employment opportunities in the biotechnology industry, as well as to promote regional economic development by providing industry with an appropriately educated workforce.

Similar to the Federal High Growth Job Training Initiative, Pennsylvania has identified High Priority Occupations on a state, region and county level. Biotechnology and Chemical Technicians, and industrial engineering technicians, are among the high priority worker titles that have been identified. (See Appendix B for employment trends data).

What Industry is Telling Us

Federal and state data are completely consistent with what we have been hearing from industry representatives in our region. Growing workforce demand in the biotechnology industry have been documented by Life Science Career Alliance (LSCA). They found that "The emerging biotechnology company is most impacted by the new biomanufacturing paradigm and the lack of skilled workers. Based on work funded through Pennsylvania, LSCA has worked with regional companies to formulate career ladders for all facets of the Industry including manufacturing. The resulting career ladders were based on extensive industry interaction including interviews, site visits, surveys and focus groups. During this process, companies reported difficulty in hiring advanced manufacturing personnel with critical skills in the key areas of fermentation and cell/tissue culture."(Biotechnology Human Capital Investment Project grant proposal submitted by LSCA to, and subsequently funded by, the US Department of Labor Employment and Training Administration)

Another area of high industry workforce need is process technology, which can be applied to a wide range of industries using a variety of manufacturing processes. For example, Sunoco has informed the College that they have hired over 100 process technicians each year for the last four years. Due to the age of their current workforce and the resulting retirements, Sunoco anticipates they will continue hiring process technicians at the same rate for the foreseeable future. Other employers in the region have also expressed concerns about their ability to hire process technicians, including Aqua America, Pepperidge Farms, Herr's, Tastykake, Coca Cola, and the Philadelphia Water Department.

Emerging Technology

There are other areas where there may not currently be a large enough student pool to support a stand-alone degree program, but which provide opportunities that the College may want to make available to students, or that have the potential to grow given effective marketing. Such programs could also be housed under the Applied Science umbrella. Two specific examples are the Nanofabrication Manufacturing Technology (NMT) program, in partnership with Pennsylvania State University, and the Biomedical Technician Training Program (BTTP) in partnership with the Wistar Institute.

The NMT program previously provided students with the opportunity to earn an AAS degree as an Option under Electronics Engineering Technology. The program incorporated the NMT capstone semester at Penn State University, which also draws students from other Pennsylvania community colleges, universities in the State System of Higher Education, Penn College of Technology, and satellite Penn State campuses. Thus, Community College of Philadelphia does not, by itself, need to identify a large ongoing student pool interested in the program, but can still provide students with the opportunity to pursue employment in NMT-related fields. The NMT courses are currently housed in the Physics Department and are listed as Engineering courses. However, they are not now part of a degree program at the College. Bringing the NMT program under the umbrella of the proposed degree as planned, will resolve this problem.

Since its inception, BTTP has provided students with direct internship opportunities at the Wistar Institute and other biomedical research institutions, which leads to a certificate. Students who are selected to participate in BTTP represent a mix of students seeking degrees with students not pursuing a degree. Degree-seeking BTTP students could be working towards a degree in virtually any curriculum offered by the college, however Culture Science and Technology (CST) and the Associate in Science are the most common route students take. One drawback to the Biomedical Technician Training Program is that the BTTP internship does not count toward any degree presently offered at the College, and only one of the three segments of the program is currently listed as a credit course. Aligning BTTP with the proposed AAS degree program would enable students to apply their credits toward a degree, making it a more attractive program to students. As with other certificate programs, there is no requirement that students seeking the BTTP certificate pursue a particular degree.

Rationale in Summary

One consequence of the accelerated pace of technological development our society is currently experiencing is to accelerate the natural, continual change in workforce needs. Offering certificates provides the College with a mechanism to rapidly respond to changing workforce needs without the need to develop an entire new curriculum, at the same time providing students with the opportunity to pursue work-related certificate programs for the short-term, and to apply their credits toward an associate degree for the long term. The College would thus be able to respond to immediate industry needs in high demand areas by offering the certificate, and to ongoing industry needs by providing a pathway for students new to the workforce. Some possible specialized certificates under current consideration include biotechnology, process technology, and nanotechnology. However, students may also tailor their curriculum to meet transfer or work-related requirements rather than completing specific certificate requirements.

In the process of fulfilling the AAS program requirements, students will build a solid foundation allowing them to transfer to 4-year institutions (if desired) to obtain degrees in aligned curricula such as biotechnology and engineering technology. The program will complement those already in place at Delaware, Bucks and Montgomery County Community Colleges, as well as other colleges in the state and region. (See Appendix C). It will also incorporate the nanotechnology courses originally housed in the Electronics Engineering Technology program and now housed in the Physics/Engineering Science Department. Finally it will expand the Biomedical Technician Training Certificate so that students will be able to receive credit for their internship experience.

Reading Area Community College has recently developed an AAS degree in Industrial Maintenance which is similar in nature to this proposed degree. They have achieved initial success by offering a certificate program to incumbent workers and they intend to begin a second phase by offering the degree program to high school graduates. At a recent presentation of the regional Workforce Investment Board, the model upon which the degree was based was well received.

III. Expected Program Participants

The proposed AAS program would be an attractive option for students of various educational and occupational backgrounds. The interdisciplinary nature of the curriculum would bring potential students to the program with a range of interests across the disciplines of science and scientific technology, and would provide students with the opportunity to move directly into the workforce as a scientific technician, or to transfer to a four-year technology program. The proposed AAS program would not be appropriate for students seeking to transfer to high level programs such as pharmacy or engineering science. Those students would be better served by the AS in Science or the AS in Engineering Science degree programs currently offered at the College. Students inquiring about or entering the AAS program who would be better served by another program at the College will be identified through the academic advising process and referred to the appropriate program.

Program participants would be drawn from a number of sources. Specific recruitment efforts would be planned in cooperation with the Office of Recruitment and Admissions, to address the needs of various student groupings. A program web page will be developed as well. It is anticipated that the bulk of students would initially consist of newly entering students coming from high school, as well as currently enrolled students. Building on relationships with community-based organizations will also provide a source of students. Outreach to industry will be carried out in coordination with Corporate Solutions.

- **High School Graduates**

  For recent high school graduates the program would be an ideal starting point to pursue a degree in the areas of biotechnology, bionanotechnology, process technology, etc. Effective recruitment efforts could draw a large number of these students from local high schools and academies. Efforts will also be made to inform high school teachers and guidance counselors about the new program. Faculty will work closely with the College recruiters to further publicize the program. Students and high school science teachers participating in the College Connection for Science, Engineering and Technology (CCSET) will be provided information about the program. CCSET is a program where high school science teachers bring a small group of their students to the College approximately five times each academic year, to perform hands-on science experiments they are unable to perform at their schools. The program is in its second year and has so far served approximately 25 students at two Philadelphia School District High Schools. Efforts are underway to expand the program to reach additional schools and a larger number of students next year.

  Some high schools in Philadelphia County have related curricula, such as Environmental Technology, Process Technology (Bok HS), and Electrical Technology. These programs are supported through the efforts of Philadelphia Academies, which has expressed a strong interest in working with us to connect their students with the proposed Associate in Applied Sciences Program. Philadelphia Academies is in the process of developing a Biotechnology Academy,

and its representatives are interested in discussing curriculum and articulation with the College. In the case of the Process Technology program at Bok High School, articulation has already been established with Delaware County Community College, to allow Bok students to enter this new degree program. Also, St. Maria Goretti High School has expressed interest in sending students to our Process Technology program.

- **Community Based Organizations**

We have established contact with the Philadelphia OIC (Opportunities Industrialization Center) and OIC America. They are developing a program to provide community members with basic skills in English and mathematics that would link directly to the proposed program, so that these individuals would be on track for employment in high technology careers. We have also had contact with the 1199c Hospital Workers Training and Upgrading Fund, which provides tuition support and a stipend for 1199c members to pursue education to expand their employment opportunities. The Fund has supported students at the College in the past, and is interested in supporting students in the proposed program (in particular in life-science areas such as biotechnology and the Biomedical Technician Training Program.).

- **Current Students**

Recruitment efforts will also focus on the general student population of the College (traditional and transitional adults). Efforts will be made to identify students who have an interest in science and to contact these students through mailings about opportunities available through the new AAS degree program. Students may be identified by such methods as examining course-taking patterns. In addition, there are currently approximately 150 CST students who have identified themselves as having an interest in science, some of whom may be interested in switching to the new AAS degree program.

Frequently new students are not aware of the opportunities that a career in science affords them. This new curriculum will be publicized in the first available Community College of Philadelphia Catalog. A brochure describing the program will be developed, and information describing the program will be sent to the Academic Advising Center, the Counseling Center, and the Admissions Office. An official launching event for the program will be held and publicized.

- **Workforce**

In addition to serving students pursuing a degree at the College, the program is also expected to attract students interested in the specific training provided by the specialized course concentrations that focus on workforce needs in specific high-demand area, such as biotechnology and process technology. These concentration areas could be marketed directly to industry—particularly to companies that may be

interested in providing ongoing training and education to their existing workforce. These activities would be coordinated with Corporate Solutions.

In addition, the program may also be of interest to students who have already earned four-year or graduate degrees and who are seeking to upgrade skills for their current careers, or to develop new skills to facilitate movement in new career directions. During economic downtimes many employees are faced by the necessity to alter or completely change careers. Since the Philadelphia area is one of the technology-rich centers of the country, work force development opportunities in the area of technologies will attract students who want to stay in the region but seek new careers. Earning a certificate that is in demand in the region is a quick way to adjust to the changing economic situation.

LSCA has offered Community College of Philadelphia the opportunity to participate in the development of two certificate programs related to Biotechnology (Fermentation and, Cell and Tissue Culture). Once the certificates are developed they intend to market them to area companies, thus providing a potential source of participants for the new degree program.

Since it is anticipated that the student base for this program will be drawn from diverse backgrounds, it is expected that the students will represent a broad demographic, including race, nationality and age. Women and minorities tend to be under-represented in science and engineering fields, and so special efforts will need to be made to encourage greater participation from these groups.

IV. Description of the Proposed Program

The proposed curriculum leads to an Associate in Applied Science in Applied Science and Engineering Technology. Program courses are divided into three main categories:

1. Courses required for all students in the program, which will provide a common foundation in topics that are common to a wide range of applied sciences
2. Courses focused on a specific applied science area, which will vary, depending on the specific direction a student pursues
3. Additional courses to fulfill any General Education requirements not already addressed through other courses

As mentioned earlier, groups of specialized courses can be clustered, and certificates of completion offered, to students who successfully complete that cluster of courses. The certificate programs could be offered as an integral part of a student's degree, and the certificate courses can be applied towards the degree. Alternatively, students could complete certificate programs independent of the degree, in pursuit of career goals. Students who opted to complete a certificate and who later decided to pursue the Associate in Applied Science degree would have a seamless transition to the degree program, since all credits earned through the certificate would also count towards the degree itself.

The design of the program provides students with multiple pathways they can pursue. They can:

1. Take one or more of the certificates, but not complete a degree.
2. Initially start with a certificate then continue on and finish the degree.
3. Opt for the degree program with a specific certificate.
4. Opt for the degree program with a specific certificate, and then add an additional certificate.
5. Opt for the degree program without a specific certificate, but develop an alternate focus with Department Head Approval.

Proposed Catalog Page

Applied Science and Engineering Technology

The Applied Science and Engineering Technology program prepares students for employment in a range of scientific technology occupations, and also provides a foundation for transfer to four-year technology programs. The flexible design of the program allows students to choose from a range of scientific technology fields, including biotechnology, nanotechnology, and process technology, among others.

The program includes a set of courses required of all students, and gives students the opportunity to select specialized courses in a particular field of interest, leading to a certificate of completion in a specialized field. Some students may initially opt to finish a certificate without completing the degree in order to directly enter the workforce. Students who do so and who later decide to pursue the Associates Degree will have a seamless transition to the degree program, since all credits earned through the certificate of completion will also count towards the degree itself.

Upon successful completion of this program, students should be able to:

- Demonstrate foundation knowledge in at least one technology field
- Demonstrate laboratory skills in basic sciences
- Demonstrate the ability to approach current societal issues from a scientific perspective
- Present technical information in oral, written or graphic format
- Work effectively as part of a team
- Articulate and practice professional skills as applied to a technical area of expertise

In addition, students will be prepared to work in a range of industries at the technician level. Below is a list of some if the positions a graduate of the program could fill (depending on which certificate or certificates are completed)

- Process Technician or Operator in industries such as oil refining, food processing, and water purification.

- Biotechnology Technician in the bio-pharmaceutical industry
- Biomedical Research Technician
- Process Analyst in a wide range of industries utilizing nanotechnology

Program Entry Requirement

This program is open to all interested students. However, some certificates offered as part of the degree are select, and students interested in particular certificate programs should consult with the Department Head. All new students are normally required to take the College's placement test at their time of entry. Students who are identified as needing developmental course work must satisfactorily complete the appropriate English and mathematics courses as a part of their degree program.

Admission to the Biomedical Technician Training Program (BTTP) is selective. BTTP is a partnership between Community College of Philadelphia and Wistar Institute. To apply, students must have completed a minimum of twelve credits at an accredited college or university with a GPA of 2.5 or better, and also completed the following courses with a grade of C or better: Math 118, English 101, Chemistry 110 or 121, and Biology 123. Students must successfully complete an in-person interview with the BTTP Academic Coordinator and BTTP Program Director from Wistar Institute.

Admission to the Nanofabrication Manufacturing Technology (NMT) Program is selective. NMT is a partnership between Community College of Philadelphia and the Center for Nanotechnology Education and Utilization at Penn State University. Students must have completed a minimum of twelve credits at an accredited college or university with a GPA of 2.5 or better, and also completed the following courses with a grade of C or better: Physics 105 (or higher) and Chemistry 110 (or higher). In addition, students must successfully complete an in-person interview with the Department Head and provide a letter of reference from an instructor of a science course taken by the student.

Students interested in one of these select programs should contact the Division of Math Science and Health Careers in Room W2-7 or by telephone at 215-751-8430 in order to learn more about the application process.

Program of Study and Graduation Requirements

A minimum of 60 credits as prescribed, must be completed with a minimum grade point average of 2.0. A minimum grade of C must be achieved in all certificate and required program courses. Specific certificates taken in conjunction with the degree may require more than 60 credits.

Applied Science and Engineering Technology Program

Course Number and Name	Prerequisites and Corequisites	Credits	Gen Ed Req.
FIRST SEMESTER			
ASET 101 Science, Technology and Public Policy		3	Science
Math 118 Intermediate Algebra		3	Math
ENGL 101 English Composition I		3	Composition
CIS 103 PC Applications		3	Tech Comp
Lab Science or Applied Science Course*		3-4	
SECOND SEMESTER			
ASET 110 Safety Health and the Environment or ENGR 211 Material, Safety & Equipment Overview for Nanofabrication		3	
Choose two**: Physics 105 Survey of Physics (or higher) OR Chem 110 Introductory Chemistry (or higher) OR BIOL 106 General Biology I or higher		8	
Math Elective or ASET 119		3	
ENGL102 English Composition II	ENGL 101	3	Composition & Info Lit
THIRD SEMESTER			
ASET 120 Quality Control / Quality Assurance		3	
Choose one** Physics 105 Survey of Physics (or higher) OR Chem 110 Introductory Chemistry (or higher) OR BIOL 106 General Biology I or higher		4	
Lab Science or Applied Science Course*		3-4	
Lab Science or Applied Science Course*		3-4	
Social Science Elective		3	Social Science
FOURTH SEMESTER			
Internship or Directed Elective*		3	
ASET 185 Ethics and Culture of the Applied Sciences Workplace		3	
Internship or Directed Elective*		3	
Humanities Elective		3	Humanities
MINIMUM CREDITS NEEDED TO GRADUATE		60	

GENERAL EDUCATION REQUIREMENTS
Students in this program are required to complete at least one course that is designated **Writing Intensive**, at least one course that is designated **Interpretive Studies** and at least one course that is designated **American/Global Diversity**. Students must choose electives that fulfill these requirements. Students may use the same course to fulfill more than one of these requirements. A list of courses which fulfill these requirements is available in this catalog or at www.ccp.edu.

*Lab Science or Applied Science courses are selected to meet specialized employment and/or transfer requirements and are selected with the approval of the Department Head.

** Students must take at least one Physics course, at least one Biology course, and at least one Chemistry course.

For More Information Contact:
The Division of Math, Science and Health Careers room W2-7, 1700 Spring Garden Street, Philadelphia, PA 19130, Telephone (215) 751-8430; or the College Information Center (215) 751 8010.

The following certificates of completion are available. Courses from these certificates may be applied towards the Associate degree.			
Biomedical Technician Training Program Certificate of Completion			
	BTT 100 Introduction to Biomedical Technology		1
	BTT 101 Biomedical Lab Internship I		3
	BTT 201 Biomedical Technology Internship II		3
Biotechnology Certificate of Completion			
	Chem 121College Chemistry I		4
	Chem 122 College Chemistry II		4
	Biol 123 Cellular and Molecular Biology		4
	Biol 211 Genetics		4
	Biol 241 Principles of Microbiology		4
	Biol 251 Biotechnology I		4
	Biol 252 Biotechnology II		4
Process Technology Competency Certificate of Completion			
	Chem 110 Introduction to Chemistry		4
	PTEC 101 Introduction to Process Control		3
	PTEC 102 Plant Equipment		2
	Math 118 Intermediate Algebra		3
	ASET 110 Safety, Health and the Environment		3
	CIS 103 PC Applications		3
Process Technology Proficiency Certificate of Completion			
	PTEC 111 Process Control I		3
	PTEC 115 Process Control II		3
	PTEC 125 Fluid Power and Controls		4
	PTEC 120 Unit Operations		3
	ASET 120 Quality Control / Quality Assurance		3
	Physics 105 Survey of Physics		4
	English 101		3
	ASET 119 Problem Solving for Technology		3
	ASET 185 Ethics and Culture Applied Sciences Workplace		3
Nanofabrication Manufacturing Technology Certificate of Completion			
	ENGR 210 Nanofabrication Manufacturing Technology Seminar		2
	ENGR 211 Material, Safety & Equipment Overview for Nanofabrication		3
	ENGR 212 Basic Nanofabrication Processes		3
	ENGR 213 Thin Films in Nanofabrication		3
	ENGR 214 Lithography for Nanofabrication		3
	ENGR 215 Materials Modification in Nanofabrication		3
	ENGR 216 Characterization, Packaging and Testing of Nanofabrication Structures		3

V. Internal Program Coherence

The proposed degree would provide a framework within which the College can address a wide range of emerging technologies for students interested in career oriented science and technology programs. Graduation requirements would be flexible, with a small number of required courses and a large number of science and technology electives. With careful advising, students could select courses that will fulfill requirements to meet their career and / or transfer goals.

To be successful in technical fields, it is necessary, but no longer sufficient, for an individual to have a good understanding of science and of the various technologies involved. As students enter the workforce, they will need to work as productive team members where oral, written and interpersonal communication are critical. A technician must also be able to communicate effectively with other team members, including other technicians, engineers, and quality assurance personnel, and must be prepared to function in a diverse work place. Teamwork and an understanding of ethical issues are also critical.

In addition, part of the College's Mission is to prepare its students to be "informed and concerned citizens." Thus students also need an understanding of the social and environmental impact of science and technology, and how the sensibilities of our society shape the direction of scientific and technological development.

There are four courses required of all ASET Degree students. The course most students are likely to take as their first course in the program is Science, Technology and Public Policy (ASET 101). The course is intended to introduce students to scientific thinking, the relationship between science and technology, and the interplay between scientific discovery and technological improvements on the one hand, and political, social and ethical issues on the other hand. Students will explore these issues through the use of case studies centered on topics related to advanced technology areas, such as nanotechnology and biotechnology. The course will also give students an introduction to possible career directions that can be achieved through the program.

Another required course is Applied Workplace Ethics and Culture (ASET 185), which is intended to address issues such as interpersonal communications, teamwork, workplace ethics, diversity in the workplace, and workplace expectations.

Two other new courses, Quality Control/Quality Assurance (ASET 120) and Safety Health and the Environment (ASET 110), are intended to introduce students to content that finds application across a broad range of industries.

The lab science and applied science courses are designed to fulfill several needs. One is to ensure that students have an introduction to each of the three major science disciplines. This is important due to the blurring of lines between biology, chemistry and physics that occurs when science is applied to solving real world problems. Specialized (applied science) courses in particular areas, such as biotechnology and process technology, will be developed to provide

students with the specific knowledge and skills needed to be successful in the target industry. Existing science courses will be utilized to provide students with the necessary scientific foundation. (For examples of certificate courses to be written, and how these courses would fit into the overall curriculum, please see Appendix D.)

General Education Plan

Students are also required to take English 101 and English 102, in order to assure that they have strong written communication skills. The requirement for courses that are writing intensive and interpretive will further enhance the written communication skills of students. Students will take CIS 103 to learn basic computer skills. Additional computer skills will be introduced in courses, such as Quality Control/Quality Assurance, and will also be included in other specific science courses, as needed.

Students are required to complete at least one math course, with additional math skills and knowledge built into the program as needed, either through additional math courses or by incorporating math into other courses. The requirement for a Social Science elective and a Humanities elective, as well as the American/Global Diversity requirement, are intended to enhance a broader perspective on the world, and an appreciation of different cultural perspectives.

VI. Program's Institutional Congruence

According to the College's Mission Statement, "Community College of Philadelphia is an open-admission, associate degree-granting institution that provides access to higher education for all who may benefit. Its programs of study in the liberal arts and sciences, career technologies, and basic academic skills provide a coherent foundation for college transfer, employment, and life-long learning. The College serves Philadelphia by preparing its students to be informed and concerned citizens, active participants in the cultural life of the city, and enabled to meet the changing needs of business, industry, and the professions."

These mission goals of the College are an integral part of the proposed program as it addresses traditional-aged students, returning adults and incumbent workers. It allows the institution to form and grow strong alliances/partnerships with its industry neighbors and to address the concern of workforce training.

The proposed degree program provides a curricular infrastructure for a range of certificate of completion programs that require a common science foundation, have a "technician-based" focus and require new courses that link directly to workplace issues (e.g. Science, Technology and Public Policy, Quality Control/Quality Assurance, Applied Workplace Ethics and Culture).

As stated earlier, the program requires the creation of a new category of courses, known as Applied Science courses. Applied Science Courses are a subset of science courses, and are distinguished from typical science courses in that they place greater emphasis on the application of scientific principles to the solution of real world problems. They share the use of scientific reasoning with other science courses.

For the present time, the ASET degree program will be housed in the Biology Department, as per agreement with the three Science Department Chairs. Overall coordination of the Program will be the responsibility of the Chair of the Biology Department, who may choose to delegate some responsibilities to a faculty member.

Initially it is anticipated that interdisciplinary courses that are housed in the new degree program may be taught by qualified faculty from existing Science Departments, which will be coordinated with the appropriate Department Heads. Adjunct faculty may be utilized for specific areas of expertise.

The proposed degree program meets existing college-wide degree requirements by requiring students to complete English 101 and English 102. The Humanities requirement and Social Science requirement will be fulfilled as electives. The electives selected by the student must also meet College requirements for American/Global Diversity, Writing Intensive, and Interpretive Studies. Students are also required to take CIS 103. The curriculum requires students to take sufficient science and mathematics to satisfy general education distribution requirements in those areas as well.

Student success in the program will be enhanced by utilizing existing educational support services. The Biology Department Chair, or designee, will work closely with the Office of Admissions to insure that students are properly informed about the opportunities available through the proposed degree program. The Science, Technology and Public Policy course is designed not only to provide students with an introduction to basic concepts of science and scientific technology and their impact on society, but also to provide students with an orientation to the various career opportunities addressed by the program.

Given the range of opportunities available to students within the program, careful advising of students is important to ensure that they are taking courses appropriate to their career and educational goals. For students who have selected ASET as their course of study, advising should be provided by faculty or counselors who are knowledgeable about the opportunities available within the program, as well as details of how students can fulfill graduation requirements.

Student academic support will be coordinated with the Learning Lab and through tutors available through some science labs. Programs with the Library will be arranged on an as-needed basis for individual courses to assist students in learning information literacy. Since many students in the program are likely to be seeking employment upon completion of the program, efforts will be coordinated with the Career Center to assist students in developing job-search skills. For students interested in transferring to a four-year program, the College will ensure that students are provided with accurate and up-to-date information regarding transfer opportunities. Students will be referred to Counseling on an as-needed basis. Faculty will collaborate with the Center On Disability to ensure that appropriate accommodations are made for students with documented disabilities.

In order to promote student engagement in the program, co-curricular activities will be developed. These activities could build on the successes and lessons of Engineering Science Keys to Success (which included outside speakers as well as providing faculty and student mentors to students early in their college career). Other possible activities include field trips, community service activities, and encouraging participation in student-run organizations such as the National Society of Black Engineers (NSBE), which has an active student chapter at the College.

A program technology plan is being developed in conjunction with the discussions currently taking place involving the Main Campus renovation project. Three new laboratories (Process Control Technology, Biotechnology, Engineering Technology) have been planned. It is anticipated that there will be a need for laboratory space to provide students with computer and Internet access which can directly interface with laboratory equipment and can support and augment hands-on laboratory experience and learning related to their field of study. In the short term, Room W4-22, the former Electronics Lab, will be utilized. This room is adequate to run a wide range of laboratory experiments and is already wired for computer and internet usage. In the long term, the program will utilize lab space being developed under the College's capital improvement project. Input will be provided to the architects to ensure that the laboratories will meet program needs. In regard to computer usage, it is anticipated that some students will also utilize existing student access areas.

Workforce initiatives will be addressed by designing/designating course blocks (program subsets) that would qualify those employed in the field or in a related field to gain a certificate of completion in a specialized application. This will provide extensive opportunities for the program to work with Corporate Solutions.

Thus the program aims to work in an interdepartmental and interdivisional framework in order to address the needs of students

VII. Proposed Courses

This section provides a summary of proposed courses which will be required for all ASET students regardless of their specific concentration. Some of the suggested concentration areas will require new courses as well, particularly Process Technology and Biotechnology. The proposed certificate courses are described in Appendix D, so that they can be seen in the context of the certificate of which they are a part.

ASET 101: Science, Technology and Public Policy (3-0-3) (Working Title)

Science and technology have come to touch the daily lives of the vast majority of the world's population. From ATM machines to cell phones to global positioning systems to digital imaging systems and new drug delivery systems, science and technology have impacted the way we do business, how we communicate and travel, and even how we care for the sick. As society has become permeated at nearly every level with scientific and technological advancements, social norms and institutions are also affected.

The purpose of this course is to provide scientific background at an introductory level in a range of areas where scientific and technological advancements have had an influence on society, as well as to study the manner in which social discourse has influenced, or has been influenced by, advances in science and technology. Possible examples for classroom discussion include:

1) Communication: from telegraph to telephone to wireless
2) Transportation: from wheel to cart to train to car
3) Process technology: from wood fires to refined petroleum
4) Economic computation: from abacus to cash register to complex computer tracking of products
5) Biotechnology and pharmaceuticals: from willow bark to aspirin to genetic engineering
6) Nanotechnology: scaling effects, environmental impact, ethical questions and policy implications

In the immediate future, it is anticipated that the focus of the course will be on biotechnology, process technology and nanotechnology, since these are subjects that will be addressed by the degree program. The selection of topics covered in the course may evolve as the program itself evolves.

Students will also explore emerging trends in the various fields of science and technology.

Upon satisfactory completion of this course students will be able to:

1. Demonstrate a basic understanding of scientific method and the process of scientific discovery
2. Explain basic principles of biology, chemistry and physics
3. Explain how basic scientific principles are applied to create new technologies
4. Discuss ways in which new technologies may impact social discourse in relation to ethical and legal considerations, government policies and spending priorities, employment trends, and so on.
5. Demonstrate basic skills in locating and utilizing library and internet resources

Students will be engaged in active learning though the use of case studies and group projects. Through these activities students will begin to appreciate the interplay between technological advances and the historical context in which they occur. This course will also be open to students not specifically enrolled in the ASET curriculum, and may be used to fulfill the science general education requirement.

ASET 110: Safety, Health and the Environment (3-0-3)

The purpose of this course is to provide students with an overview various types of hazards that may be arise in an industrial setting, as well as the types of engineering controls, administrative controls, personal protective equipment, and current safety, health and environmental regulations that affect these industries. Major topics that will be covered in the course include:

- Types of hazards
  - Chemical
  - Physical
  - Ergonomic
  - Biological
  - Security
    - Physical security
    - Cyber security
  - Environmental
    - Air pollution
    - Water pollution
    - Soil pollution
- Regulatory Agencies
  - Occupational Safety and Health Administration
  - Environmental Protection Agency
  - Department of Transportation
  - Nuclear Regulatory Commission
  - Food and Drug Administration
- Voluntary Standards
  - International Organization of Standardization
  - National Fire Protection Association
  - American National Standards Institute
  - American Society for Testing and Materials
  - National Safety Council
- Engineering controls
- Administrative controls
- Personal protective equipment

At the conclusion of the course it is expected that students will be able to:

- Define what a hazard is and identify different types of safety, health and environmental hazards
- Explain the role of regulatory agencies that have jurisdiction over industrial safety, health and environmental hazards
- Explain the role of voluntary standards in industry
- Explain how safety issues can be addressed through the use of
  - engineering controls
  - administrative controls
  - personal protective equipment
  - training

Students will be engaged in active learning through classroom discussions, group projects, case studies, and oral reports. Students will be expected to analyze real and/or hypothetical

situations to determine compliance with applicable regulations, and explain appropriate engineering, administrative, and individual responses to hazardous conditions.

ASET 120: Quality Control / Quality Assurance (3-0-3)

Quality can be defined as "the characteristics of a product or service that bear on its ability to satisfy stated or implied needs" (American Society for Quality (ASQ) web site). Continuous improvement of quality has become integrated into the operations of both manufacturing and service industries. The ASQ web site defines quality assurance as "all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality." One definition for quality control is "the operational techniques and activities used to fulfill requirements for quality."

The purpose of this course is to provide students with an overview of the concepts of quality assurance and quality control. Major topics will include:

- What is quality and why is it important
- The role of technicians in quality control
- Records and documentation
- Material inspection and evaluation
- Sampling
- Statistical process control
- Six Sigma
- Current Good Manufacturing Practices (cGMP)
- ISO 9000
- Government regulations
- Manufacturing in a regulated environment
- Application of QA/QC to different industries

At the conclusion of the course it is expected that students will be able to:

- Define quality, quality control and quality assurance
- Explain the importance of record keeping and documentation
- Describe basic methods of inspecting and evaluating materials
- Explain the basic approach of statistical process control, six sigma, cGMP and ISO 9000
- Describe the impact of government regulations on manufacturing
- Analyze real or hypothetical data from a QA/QC perspective

Students will be engaged in active learning through classroom discussions, group projects, case studies, and oral reports. Students will be expected to analyze real and/or hypothetical situations and to apply principles of statistical process control, six sigma, cGMP, and other concepts of quality assurance and quality control, to determine if a process is in control, and if the process can be improved.

ASET 185: Ethics and Culture of the Applied Sciences Workplace (3-0-3) (Working Title)

In the face of globalization, today's workplace requires individuals able to work closely and effectively with others of different backgrounds and ages, who may hold different viewpoints. The purpose of the course is to provide students with both a practical and theoretical understanding of issues important for workplace success. This course will bring together a range of interrelated "soft" skills and knowledge that are essential for success in today's applied sciences workplace, including:

- Teamwork
- diversity in the workplace
- oral and interpersonal communication
- time management
- understanding and adapting to the culture of a workplace
- ethical behavior in the workplace
- employee rights and responsibilities

For each topic covered, students will be provided with a basic theoretical framework for understanding of the topic, as well as the opportunity to apply the theoretical framework to real or hypothetical situations similar to those they might encounter as a technician in an applied sciences workplace. For example, under the topic of teamwork, students could be introduced to basic theory of group dynamics, and then apply that knowledge as they work on a group project in the class. Students could be provided with a basic conceptual understanding of ethics, and could then explore how this understanding could be applied through the uses of role-plays, hypothetical situations, and case studies.

Students will be engaged in active learning through classroom discussion, role playing, team building activities, group projects, oral reports, and analysis of case studies. At the conclusion of the course, it is expected that students will be able to apply basic concepts learned in the course to the solution of real or hypothetical workplace challenges in the areas listed above.

VIII. Fiscal Implications

A. Projected Enrollment

Projected enrollment for the first year is 30-50 students, drawn from newly entering students, students currently enrolled in CST who may wish to transfer to the new curriculum, and from students drawn from Business and Industry contacts. It is anticipated that this number will increase to 75 students during the second year, provided adequate recruitment and retention efforts are in place. In the next 3-5 years, it is anticipated that the enrollment will stabilize at approximately 100 students.

B. Projected Budget

1. Capital Equipment and Cost.

There is likely to be a need for specialized laboratory equipment for some program areas. For example, it is estimated that basic laboratory equipment costs for biotechnology will be approximately $200,000, and for process technology approximately $75,000. Outside funding will be sought from agencies such as the National Science Foundation, the US Department of Labor, and the State Department of Community and Economic Development to address these costs. The College is currently serving on the Life Sciences Career Alliance's Biotechnology Project Advisory Board, and is thus eligible to apply for, and likely to receive, a portion of the funding LSCA is making available for equipment purchase under a US Department of Labor grant. Some equipment has already been acquired through a grant with Montgomery County Community College. The College is also participating in a Community Based Job Grant with Delaware County Community College and Montgomery County Community College and is eligible for at least $ 40,000 for process technology equipment.

2. Additional Operating Budget Cost.

During the first year of the program, the following operating expenses are anticipated:

Lab Supplies	$10,000
Equipment Maintenance	$500

Since the first year will require some start-up costs, it is anticipated that the supplies line will decrease in subsequent years to approximately $3,000 per year. Supply needs for specialized courses in the Biology, Chemistry or Physics Departments will be met under the program budget. The equipment maintenance line is likely to increase over time, as equipment goes out of warranty and the need for service contracts arises.

3. Space Requirements.

The College is currently engaged in planning to renovate lab space in the West Building as part of a capital improvement program. The newly renovated labs will be designed to meet the needs of programs in biotechnology, process technology and engineering technology (including computer technology needs), and will be designed to allow for flexible use of the space. Lab space for biotechnology could also be utilized by the Biology Department to supplement their need for additional lab space for microbiology. Pending completion of the new lab space, it is anticipated that Process Technology could temporarily share the lab in room W4-22 with the proposed Engineering Technology Program. It is anticipated that new lab space for biotechnology will also be provided at the Northeast Regional Center. Office space for faculty and for the biotechnology program should also be provided at the Northeast Regional Center.

4. Program Support Structure and Cost.

As noted above, the room currently projected to be the Process Technology laboratory is, in the short term, adequate for laboratory use. The room is already wired for computer and Internet usage. Other new labs will need to be appropriately designed to meet program needs, and will

need to be fully wired and provided with computers for student use. These requirements are currently under discussion as part of the Main Campus Renovation Project.

In order to meet marketing needs for the program it will be necessary to develop and print new brochures, maintain a Program web site, as well as have support from the Office of Recruitment and Admissions. As indicated earlier, because of the flexible nature of the program, career and transfer counseling, as well as effective academic advising, will be important for students in the program. As stated earlier, there will also need to be support from existing College programs, such as the Learning Lab and the Library. Contact with Library staff has been initiated. While the Library collection does include some books related to biotechnology, nanotechnology and process technology, only a small portion of them have copyrights less than five years old. A significant portion of the books are more than ten years old. The Biology Department Chair, or designee, and faculty, who write new courses, will work with Library staff to identify material that is out of date for removal from the shelves, and to suggest new material for acquisition, as new courses are being developed.

Appendix A

Science Technicians
Occupational Outlook Handbook
2008-2009 Edition

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2008-09 Edition*, Science Technicians, on the Internet at **http://www.bls.gov/oco/ocos115.htm** (visited *October 26, 2008*).

Occupational Outlook Handbook, 2008-09 Edition

(PDF)

Science Technicians

Significant Points

- Science technicians in production jobs can be employed on day, evening, or night shifts; other technicians work outdoors, sometimes in remote locations.
- Most science technicians need an associate degree or a certificate in applied science or science-related technology; biological and forensic science technicians usually need a bachelor's degree.
- Projected job growth varies among occupational specialties; for example, forensic science technicians will grow much faster than average, while chemical technicians will grow more slowly than average.
- Job opportunities are expected to be best for graduates of applied science technology programs who are well trained on equipment used in laboratories or production facilities.

Nature of the Work [About this section] Back to Top

Science technicians use the principles and theories of science and mathematics to solve problems in research and development and to help invent and improve products and processes. However, their jobs are more practically oriented than those of scientists. Technicians set up, operate, and maintain laboratory instruments, monitor experiments, make observations, calculate and record results, and often develop conclusions. They must keep detailed logs of all of their work. Those who perform production work monitor manufacturing processes and may ensure quality by testing products for proper proportions of ingredients, for purity, or for strength and durability.

As laboratory instrumentation and procedures have become more complex, the role of science technicians in research and development has expanded. In addition to performing routine tasks, many technicians, under the direction of scientists, now develop and adapt laboratory procedures to achieve the best results, interpret data, and devise solutions to problems. Technicians must develop expert knowledge of laboratory equipment so that they can adjust settings when necessary and recognize when equipment is malfunctioning.

Most science technicians specialize, learning their skills and working in the same disciplines in which scientists work. Occupational titles, therefore, tend to follow the same structure as those for scientists.

Agricultural and food science technicians work with related scientists to conduct research, development, and testing on food and other agricultural products. Agricultural technicians are involved in food, fiber, and animal research, production, and processing. Some conduct tests and experiments to improve the yield and quality of crops or to increase the resistance of plants and animals to disease, insects, or other hazards. Other agricultural technicians breed animals for the purpose of investigating nutrition. Food science technicians assist food scientists and technologists in research and development, production technology, and quality control. For example, food science technicians may conduct tests on food additives and preservatives to ensure compliance with Food and Drug Administration regulations regarding color,

texture, and nutrients. These technicians analyze, record, and compile test results; order supplies to maintain laboratory inventory; and clean and sterilize laboratory equipment.

Biological technicians work with biologists studying living organisms. Many assist scientists who conduct medical research—helping to find a cure for cancer or AIDS, for example. Those who work in pharmaceutical companies help develop and manufacture medicine. Those working in the field of microbiology generally work as laboratory assistants, studying living organisms and infectious agents. Biological technicians also analyze organic substances, such as blood, food, and drugs. Biological technicians working in biotechnology apply knowledge and techniques gained from basic research, including gene splicing and recombinant DNA, and apply them to product development.

Chemical technicians work with chemists and chemical engineers, developing and using chemicals and related products and equipment. Generally, there are two types of chemical technicians: research technicians who work in experimental laboratories and process control technicians who work in manufacturing or other industrial plants. Many chemical technicians working in research and development conduct a variety of laboratory procedures, from routine process control to complex research projects. For example, they may collect and analyze samples of air and water to monitor pollution levels, or they may produce compounds through complex organic synthesis. Most *process technicians* work in manufacturing, testing packaging for design, integrity of materials, and environmental acceptability. Often, process technicians who work in plants focus on quality assurance, monitoring product quality or production processes and developing new production techniques. A few work in shipping to provide technical support and expertise.

Environmental science and protection technicians perform laboratory and field tests to monitor environmental resources and determine the contaminants and sources of pollution in the environment. They may collect samples for testing or be involved in abating and controlling sources of environmental pollution. Some are responsible for waste management operations, control and management of hazardous materials inventory, or general activities involving regulatory compliance. Many environmental science technicians employed at private consulting firms work directly under the supervision of an environmental scientist.

Forensic science technicians investigate crimes by collecting and analyzing physical evidence. Often, they specialize in areas such as DNA analysis or firearm examination, performing tests on weapons or on substances such as fiber, glass, hair, tissue, and body fluids to determine their significance to the investigation. Proper collection and storage methods are important to protect the evidence. Forensic science technicians also prepare reports to document their findings and the laboratory techniques used, and they may provide information and expert opinions to investigators. When criminal cases come to trial, forensic science technicians often give testimony as expert witnesses on laboratory findings by identifying and classifying substances, materials, and other evidence collected at the scene of a crime. Some forensic science technicians work closely with other experts or technicians. For example, a forensic science technician may consult either a medical expert about the exact time and cause of a death or another technician who specializes in DNA typing in hopes of matching a DNA type to a suspect.

Forest and conservation technicians compile data on the size, content, and condition of forest land. These workers usually work in a forest under the supervision of a forester, doing specific tasks such as measuring timber, supervising harvesting operations, assisting in road building operations, and locating property lines and features. They also may gather basic information, such as data on populations of trees, disease and insect damage, tree seedling mortality, and conditions that may pose a fire hazard. In addition, forest and conservation technicians train and lead forest and conservation workers in seasonal activities, such as planting tree seedlings, and maintaining recreational facilities. Increasing numbers of forest and conservation technicians work in urban forestry—the study of individual trees in cities—and other nontraditional specialties, rather than in forests or rural areas.

Geological and petroleum technicians measure and record physical and geologic conditions in oil or gas wells, using advanced instruments lowered into the wells or analyzing the mud from the wells. In oil and gas exploration, technicians collect and examine geological data or test geological samples to determine their petroleum content and their mineral and element composition. Some petroleum technicians, called scouts, collect information about oil well and gas well drilling operations, geological and geophysical prospecting, and land or lease contracts.

Nuclear technicians operate nuclear test and research equipment, monitor radiation, and assist nuclear engineers and physicists in research. Some also operate remote controlled equipment to manipulate radioactive materials or materials exposed to radioactivity. Workers who control nuclear reactors are classified as *nuclear power reactor operators*, and are not included in this statement. (See the statement on power plant operators, distributors, and dispatchers elsewhere in the *Handbook*.)

Other science technicians perform a wide range of activities. Some collect weather information or assist oceanographers; others work as laser technicians or radiographers.

Work environment. Science technicians work under a wide variety of conditions. Most work indoors, usually in laboratories, and have regular hours. Some occasionally work irregular hours to monitor experiments that cannot be completed during regular working hours. Production technicians often work in 8-hour shifts around the clock. Others, such as agricultural, forest and conservation, geological and petroleum, and environmental science and protection technicians, perform much of their work outdoors, sometimes in remote locations.

Advances in automation and information technology require technicians to operate more sophisticated laboratory equipment. Science technicians make extensive use of computers, electronic measuring equipment, and traditional experimental apparatus.

Some science technicians may be exposed to hazards from equipment, chemicals, or toxic materials. Chemical technicians sometimes work with toxic chemicals or radioactive isotopes; nuclear technicians may be exposed to radiation, and biological technicians sometimes work with disease-causing organisms or radioactive agents. Forensic science technicians often are exposed to human body fluids and firearms. However, these working conditions pose little risk if proper safety procedures are followed. For forensic science technicians, collecting evidence from crime scenes can be distressing and unpleasant.

Training, Other Qualifications, and Advancement

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Most science technicians need an associate degree or a certificate in applied science or science-related technology. Biological and forensic science technicians usually need a bachelor's degree. Science technicians with a high school diploma and no college degree typically begin work as trainees under the direct supervision of a more experienced technician, and eventually earn a 2-year degree in science technology.

Education and training. There are several ways to qualify for a job as a science technician. Many employers prefer applicants who have at least 2 years of specialized training or an associate degree in applied science or science-related technology. Because employers' preferences vary, however, some science technicians have a bachelor's degree in chemistry, biology, or forensic science or have completed several science and math courses at a 4-year college.

Most biological technician jobs, for example, require a bachelor's degree in biology or a closely related field. Forensic science positions also typically require a bachelor's degree to work in the field. Knowledge and understanding of legal procedures also can be helpful. Chemical technician positions in research and development also often have a bachelor's degree, but most chemical process technicians have a 2-year degree instead, usually an associate degree in process technology. In some cases, a high school diploma is sufficient. These workers usually receive additional on-the-job training. Entry-level workers whose college training encompasses extensive hands-on experience with a variety of diagnostic laboratory equipment generally require less on-the-job training.

Whatever their degree, science technicians usually need hands-on training either in school or on the job. Most can get good career preparation through 2-year formal training programs that combine the teaching of scientific principles and theory with practical hands-on application in a laboratory setting with up-to-date equipment. Graduates of bachelor's degree programs in science who have considerable experience in laboratory-based courses, have completed internships, or have held summer jobs in laboratories also are well qualified for science technician positions and are preferred by some employers.

Job candidates, who have extensive hands-on experience with a variety of laboratory equipment, including computers and related equipment, usually require a short period of on-the-job training. Those with a high school diploma and no college degree typically begin work as trainees under the direct supervision of a more experienced technician. Many with a high school diploma eventually earn a 2-year degree in science technology, often paid for by their employer.

Many technical and community colleges offer associate degrees in a specific technology or more general education in science and mathematics. A number of associate degree programs are designed to provide easy transfer to bachelor's degree programs at colleges or universities. Technical institutes usually offer technician training, but they provide less theory and general education than do community colleges. The length of programs at technical institutes varies, although 1-year certificate programs and 2-year associate degree programs

are common. Prospective forestry and conservation technicians can choose from more than 20 associate degree programs in forest technology accredited by the Society of American Foresters.

Approximately 30 colleges and universities offer a bachelor's degree program in forensic science; about another 25 schools offer a bachelor's degree in a natural science with an emphasis on forensic science or criminology; a few additional schools offer a bachelor's degree with an emphasis in a specialty area, such as criminology, pathology, jurisprudence, investigation, odontology, toxicology, or forensic accounting.

Some schools offer cooperative-education or internship programs, allowing students the opportunity to work at a local company or some other workplace while attending classes during alternate terms. Participation in such programs can significantly enhance a student's employment prospects.

People interested in careers as science technicians should take as many high school science and math courses as possible. Science courses taken beyond high school, in an associate or bachelor's degree program, should be laboratory oriented, with an emphasis on bench skills. A solid background in applied chemistry, physics, and math is vital.

Other qualifications. Communication skills are important because technicians are often required to report their findings both orally and in writing. In addition, technicians should be able to work well with others. Because computers often are used in research and development laboratories, technicians should also have strong computer skills, especially in computer modeling. Organizational ability, an eye for detail, and skill in interpreting scientific results are important as well, as are a high mechanical aptitude, attention to detail, and analytical thinking.

Advancement. Technicians usually begin work as trainees in routine positions under the direct supervision of a scientist or a more experienced technician. As they gain experience, technicians take on more responsibility and carry out assignments under only general supervision, and some eventually become supervisors. However, technicians employed at universities often have job prospects tied to those of particular professors; when those professors retire or leave, these technicians face uncertain employment prospects.

Employment

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Science technicians held about 267,000 jobs in 2006. As indicated by the following tabulation, chemical and biological technicians accounted for 52 percent of all jobs:

Biological technicians	79,000
Chemical technicians	61,000
Environmental science and protection technicians, including health	37,000
Forest and conservation technicians	34,000
Agricultural and food science technicians	26,000
Forensic science technicians	13,000
Geological and petroleum technicians	12,000
Nuclear technicians	6,500

About 30 percent of biological technicians worked in professional, scientific, or technical services firms; most other biological technicians worked in educational services, Federal, State, and local governments, or pharmaceutical and medicine manufacturing. Chemical technicians held jobs in a wide range of manufacturing and service-providing industries. About 39 percent worked in chemical manufacturing and another 30 percent worked in professional, scientific, or technical services firms. Most environmental science and protection technicians worked for State and local governments and professional, scientific, and technical services firms. About 76 percent of forest and conservation technicians held jobs in the Federal Government, mostly in the Forest Service; another 17 percent worked for State governments. Around 32 percent of agricultural and food science technicians worked in educational services and 20 percent worked for food processing companies; most of the rest were employed in agriculture. Forensic science technicians worked primarily for State and local governments. Approximately 37 percent of all geological and petroleum technicians worked for oil and gas extraction companies and 49 percent of nuclear technicians worked for utilities.

Job Outlook

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Employment of science technicians is projected to grow about as fast as the average, although employment change will vary by specialty. Job opportunities are expected to be best for graduates of applied science technology programs who are well trained on equipment used in laboratories or production facilities.

Employment change. Overall employment of science technicians is expected to grow 12 percent during the 2006-16 decade, about as fast as the average for all occupations. The continued growth of scientific and medical research—particularly research related to biotechnology—will be the primary driver of employment growth, but the development and production of technical products should also stimulate demand for science technicians in many industries.

Employment of biological technicians should increase faster than the average, as the growing number of agricultural and medicinal products developed with the use of biotechnology techniques boosts demand for these workers. Also, an aging population and stronger competition among pharmaceutical companies are expected to contribute to the need for innovative and improved drugs, further spurring demand. Most growth in employment will be in professional, scientific, and technical services and in educational services.

Job growth for chemical technicians is projected to grow more slowly than the average. The chemical manufacturing industry, except pharmaceutical and medicine manufacturing, is anticipated to experience a decline in overall employment as companies downsize and turn to outside contractors to provide specialized services. Some of these contractors will be in other countries with lower average wages, further limiting employment growth. An increasing focus on quality assurance will require a greater number of process technicians, however, stimulating demand for these workers.

Employment of environmental science and protection technicians is expected to grow much faster than the average; these workers will be needed to help regulate waste products; to collect air, water, and soil samples for measuring levels of pollutants; to monitor compliance with environmental regulations; and to clean up contaminated sites. Over 80 percent of this growth is expected to be in professional, scientific, and technical services as environmental monitoring, management, and regulatory compliance increase.

An expected decline in employment of forest and conservation technicians within the Federal Government will lead to little or no change in employment in this specialty, due to budgetary constraints and continued reductions in demand for timber management on Federal lands. However, opportunities at State and local governments within specialties such as urban forestry may provide some new jobs. In addition, an increased emphasis on specific conservation issues, such as environmental protection, preservation of water resources, and control of exotic and invasive pests, may provide some employment opportunities.

Employment of agricultural and food science technicians is projected to grow about as fast as the average. Research in biotechnology and other areas of agricultural science will increase as it becomes more important to balance greater agricultural output with protection and preservation of soil, water, and the ecosystem. In particular, research will be needed to combat insects and diseases as they adapt to pesticides and as soil fertility and water quality continue to need improvement.

Jobs for forensic science technicians are expected to increase much faster than the average. Employment growth in State and local government should be driven by the increasing application of forensic science to examine, solve, and prevent crime. Crime scene technicians who work for State and county crime labs should experience favorable employment prospects resulting from strong job growth.

Average employment growth is expected for geological and petroleum technicians. Job growth should be strongest in professional, scientific, and technical services firms because geological and petroleum technicians will be needed to assist environmental scientists and geoscientists as they provide consultation services for companies regarding environmental policy and Federal Government mandates, such as those requiring lower sulfur emissions.

Nuclear technicians should grow about as fast as the average as more are needed to monitor the Nation's aging fleet of nuclear reactors and research future advances in nuclear power. Although no new nuclear powerplants have been built for decades in the United States, energy demand has recently renewed interest in this form of electricity generation and may lead to future construction. Technicians also will be needed to work in defense-related areas, to develop nuclear medical technology, and to improve and enforce waste management and safety standards.

Job prospects. In addition to job openings created by growth, many openings should arise from the need to replace technicians who retire or leave the labor force for other reasons. Job opportunities are expected to be best for graduates of applied science technology programs who are well trained on equipment used in laboratories or production facilities. As the instrumentation and techniques used in industrial research, development, and production become increasingly more complex, employers will seek individuals with highly developed technical skills. Good communication skills are also increasingly sought by employers.

Job opportunities vary by specialty. The best opportunities for agricultural and food science technicians will be in agricultural biotechnology, specifically in research and development on biofuels. Geological and petroleum technicians should experience little competition for positions because of the relatively small number of new entrants. Forensic science technicians with a bachelor's degree in a forensic science will enjoy much better opportunities than those with an associate degree. During periods of economic recession, science technicians may be laid off.

Projections Data

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Projections data from the National Employment Matrix

Occupational title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16		Detailed statistics	
				Number	Percent		
Science technicians	--	267,000	300,000	33,000	12	--	--
Agricultural and food science technicians	19-4011	26,000	28,000	1,700	7	PDF	zipped XLS
Biological technicians	19-4021	79,000	91,000	13,000	16	PDF	zipped XLS
Chemical technicians	19-4031	61,000	65,000	3,600	6	PDF	zipped XLS
Geological and petroleum technicians	19-4041	12,000	13,000	1,000	9	PDF	zipped XLS
Nuclear technicians	19-4051	6,500	6,900	400	7	PDF	zipped XLS
Environmental science and protection technicians, including health	19-4091	37,000	47,000	10,000	28	PDF	zipped XLS
Forensic science technicians	19-4092	13,000	17,000	4,000	31	PDF	zipped XLS
Forest and conservation technicians	19-4093	34,000	33,000	-700	-2	PDF	zipped XLS

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

Earnings

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Median hourly earnings of science technicians in May 2006 were as follows:

Nuclear technicians	$31.49
Geological and petroleum technicians	22.19
Forensic science technicians	21.79
Chemical technicians	18.87
Environmental science and protection technicians, including health	18.31
Biological technicians	17.17
Agricultural and food science technicians	15.26
Forest and conservation technicians	14.84

In 2007, the average annual salary in the Federal Government was $40,629 for biological science technicians; $53,026 for physical science technicians; $40,534 for forestry technicians; $54,081 for geodetic technicians; $50,337 for hydrologic technicians; and $63,396 for meteorological technicians.

For the latest wage information:

The above wage data are from the Occupational Employment Statistics (OES) survey program, unless otherwise noted. For the latest National, State, and local earnings data, visit the following pages:

- Agricultural and food science technicians
- Biological technicians
- Chemical technicians
- Geological and petroleum technicians
- Nuclear technicians
- Environmental science and protection technicians, including health
- Forensic science technicians
- Forest and conservation technicians

Related Occupations

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Other technicians who apply scientific principles and who usually have a 2-year associate degree include engineering technicians, broadcast and sound engineering technicians and radio operators, drafters, and health technologists and technicians—especially clinical laboratory technologists and technicians, diagnostic medical sonographers, and radiologic technologists and technicians.

Sources of Additional Information

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Disclaimer:
Links to non-BLS Internet sites are provided for your convenience and do not constitute an endorsement.

For information about a career as a chemical technician, contact:

American Chemical Society, Education Division, Career Publications, 1155 16th St. NW., Washington, DC 20036. Internet: http://www.acs.org

For career information and a list of undergraduate, graduate, and doctoral programs in forensic sciences, contact:

American Academy of Forensic Sciences, P.O. Box 669, Colorado Springs, CO, 80901. Internet: http://www.aafs.org

For general information on forestry technicians and a list of schools offering education in forestry, send a self-addressed, stamped business envelope to:

Society of American Foresters, 5400 Grosvenor Ln., Bethesda, MD 20814. Internet: http://www.safnet.org

OOH ONET Codes

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19-4011.00, 19-4011.01, 19-4011.02, 19-4021.00, 19-4031.00, 19-4041.00, 19-4041.01, 19-4041.02, 19-4051.00, 19-4051.01, 19-4051.02, 19-4091.00, 19-4092.00, 19-4093.00, 19-4099.99

Suggested citation: Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2008-09 Edition*, Science Technicians, on the Internet at **http://www.bls.gov/oco/ocos115.htm** (visited *October 26, 2008*).

Last Modified Date: December 18, 2007

Appendix B
Employment Data

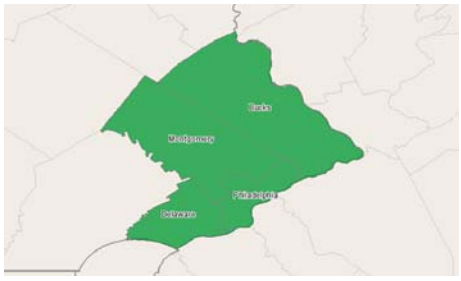
Community College of Philadelphia

1700 Spring Garden Street

Philadelphia, Pennsylvania 19130

215.751.8350

Occupation Report



Region Info

Region: Phila area

Counties: Bucks, PA (42017), Delaware, PA (42045), Montgomery, PA (42091), Philadelphia, PA (42101)

Executive Summary

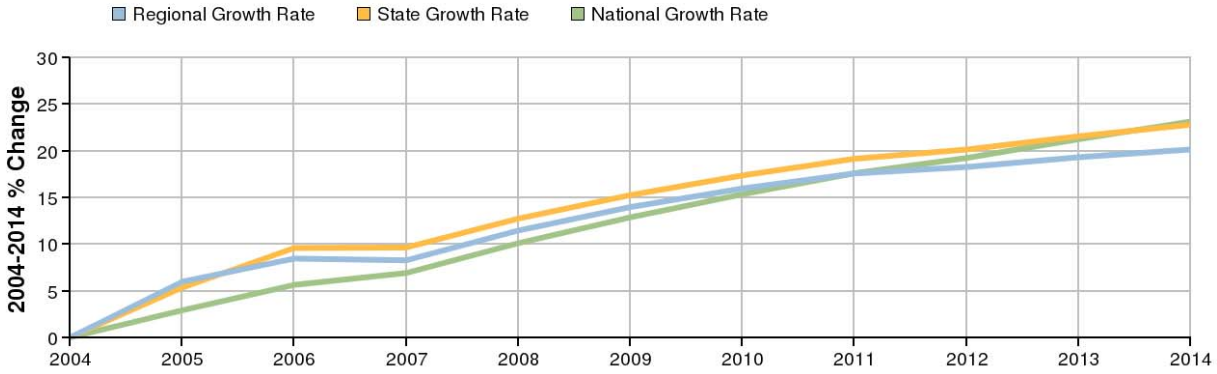
Selected Occupations	Education Level
Biological technicians (SOC 19-4021)	Associate's degree

Basic Information	
2004 Occupational Jobs	2,654
2014 Occupational Jobs	3,188
Total Change	534
Total % Change	20.12%
2007 Median Hourly Earnings	$17.86

Economic Indicators	
2004 Location Quotient	3.16
2014 Location Quotient	3.32

Source: EMSI Complete Employment - Spring 2008 Release v. 2

Occupational Change Summary



Region	2004 Jobs	2014 Jobs	Change	% Change	2007 Median Hourly Earnings
Regional Total	2,654	3,188	534	20%	$17.86
State Total	4,273	5,247	974	23%	$17.47
National Total	72,573	89,347	16,774	23%	$17.87

Source: EMSI Complete Employment - Spring 2008 Release v. 2

Data Sources and Calculations

State Data Sources

This report uses state data from the following agencies: Pennsylvania Department of Labor and Industry, Center for Workforce Information and Analysis.

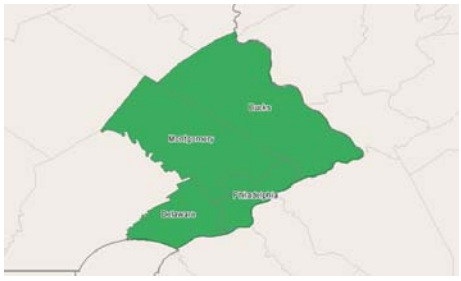
Community College of Philadelphia

1700 Spring Garden Street

Philadelphia, Pennsylvania 19130

215.751.8350

Occupation Report



Region Info

Region: Phila area

Counties: Bucks, PA (42017), Delaware, PA (42045), Montgomery, PA (42091), Philadelphia, PA (42101)

Executive Summary

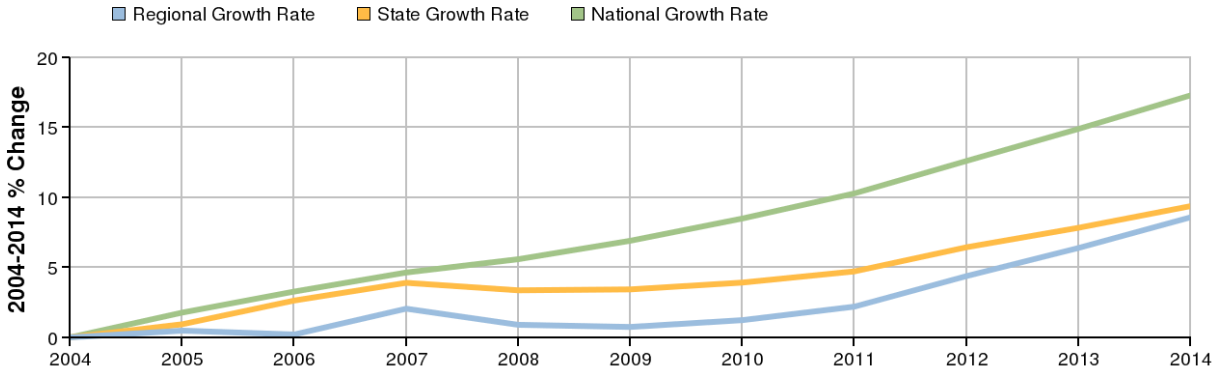
Selected Occupations	Education Level
Industrial engineering technicians (SOC 17-3026)	Associate's degree

Basic Information	
2004 Occupational Jobs	899
2014 Occupational Jobs	976
Total Change	77
Total % Change	8.57%
2007 Median Hourly Earnings	$26.39

Economic Indicators	
2004 Location Quotient	1.07
2014 Location Quotient	1.07

Source: EMSI Complete Employment - Spring 2008 Release v. 2

Occupational Change Summary



Region	2004 Jobs	2014 Jobs	Change	% Change	2007 Median Hourly Earnings
Regional Total	899	976	77	9%	$26.39
State Total	3,681	4,026	345	9%	$22.50
National Total	72,409	84,922	12,513	17%	$22.96

Source: EMSI Complete Employment - Spring 2008 Release v. 2

Data Sources and Calculations

State Data Sources

This report uses state data from the following agencies: Pennsylvania Department of Labor and Industry, Center for Workforce Information and Analysis.

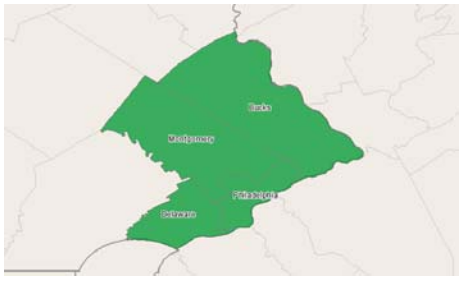
Community College of Philadelphia

1700 Spring Garden Street

Philadelphia, Pennsylvania 19130

215.751.8350

Occupation Report



Region Info

Region: Phila area

Counties: Bucks, PA (42017), Delaware, PA (42045), Montgomery, PA (42091), Philadelphia, PA (42101)

Executive Summary

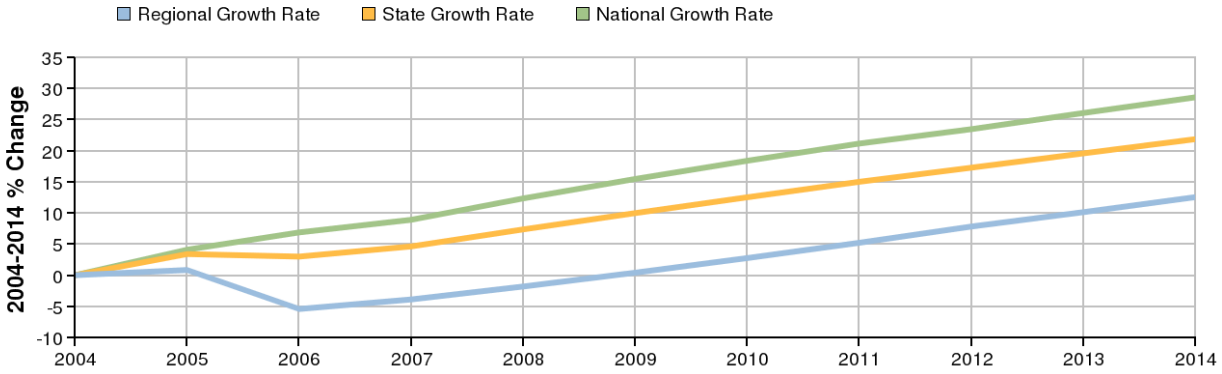
Selected Occupations	Education Level
Medical equipment repairers (SOC 49-9062)	Associate's degree

Basic Information	
2004 Occupational Jobs	622
2014 Occupational Jobs	700
Total Change	78
Total % Change	12.55%
2007 Median Hourly Earnings	$18.82

Economic Indicators	
2004 Location Quotient	1.39
2014 Location Quotient	1.31

Source: EMSI Complete Employment - Spring 2008 Release v. 2

Occupational Change Summary



Region	2004 Jobs	2014 Jobs	Change	% Change	2007 Median Hourly Earnings
Regional Total	622	700	78	13%	$18.82
State Total	1,872	2,281	409	22%	$18.62
National Total	38,532	49,541	11,009	29%	$16.84

Source: EMSI Complete Employment - Spring 2008 Release v. 2

Data Sources and Calculations

State Data Sources

This report uses state data from the following agencies: Pennsylvania Department of Labor and Industry, Center for Workforce Information and Analysis.

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OSDS OCCUPATIONAL SUPPLY DEMAND SYSTEM

Supply Indicators | Demand Indicators | Pennsylvania

Home > Select > BIOLOGICAL TECHNOLOGY > Demand Indicators

Occupational Characteristics — Pennsylvania

SOC Code	Occupation	Minimum Educ Level	2004-2014 Growth	2007 Wages	Licensing	Self-Empl
19-4021	Biological Technicians	Associate degree	Average	$36,060		.0%

Source: U.S. Department of Labor and America's Career InfoNet (licensing).

Occupational Projections — Pennsylvania

		Employment			Average Annual Openings		
SOC code	Occupation	Est 2004	Proj 2014	Change	Growth	Replace	Total
19-4021	Biological Technicians	2,744	3,190	16.3%	45	46	91
	Total	2,744	3,190	16.3%	45	46	91

Source: U.S. Department of Labor

Wage Trends — Pennsylvania

		Median Annual Wage					Change
SOC Code	Occupation	2003	2004	2005	2006	2007	2003 to 2007
19-4021	Biological Technicians	$35,960	$33,980	$32,410	$34,840	$36,060	.3%
Benchmarks for Wage Trends (all occupations)		**2003**	**2004**	**2005**	**2006**	**2007**	**Change 2003 to 2007**
Pennsylvania Median Wage		$27,870	$28,430	$28,800	$29,800	$30,840	10.7%
Pennsylvania Mean Wage		$35,060	$35,780	$36,320	$37,580	$38,960	11.1%
Pennsylvania Mean Wage RSE		0.5%	0.5%	0.4%	0.4%	0.4%	
National Median Wage		$28,140	$28,770	$29,430	$30,400	$31,410	11.6%
National Mean Wage		$36,210	$37,020	$37,870	$39,190	$40,690	12.4%
National Mean Wage RSE		0.2%	0.2%	0.1%	0.1%	0.1%	
National Consumer Price Index (C-CPI-U)		107.8	110.5	113.7	117.0	119.9	11.2%

Note: Relative Standard Error (RSE) is a measure of the reliability of a statistic; the smaller the relative standard error, the more precise the estimate. Source: U.S. Department of Labor

Occupational Employment by Industry (Top 5 Industries) — National

				Occupation Employment			Pct. of Total	
SOC Code	Occupation	NAICS Code	Industry	2006	2016	Change	2006	2016

19-4021	Biological Technicians	611300	Colleges, universities, and professional schools, public and private	24,163	29,735	23.1%	30.7%	32.6%
19-4021		541700	Scientific research and development services	19,900	23,319	17.2%	25.3%	25.5%
19-4021		919999	Federal government, excluding postal service	12,311	11,638	-5.5%	15.6%	12.8%
19-4021		325400	Pharmaceutical and medicine manufacturing	7,194	9,067	26.0%	9.1%	9.9%
19-4021		949400	State and local government, excluding education and hospitals	3,517	3,553	1.1%	4.5%	3.9%

OSDS OCCUPATIONAL SUPPLY DEMAND SYSTEM

Supply Indicators | Demand Indicators | Pennsylvania

Home > Select > INDUSTRIAL/MANUFACTURING TECHNOLOGY > Demand Indicators

Occupational Characteristics — Pennsylvania

SOC Code	Occupation	Minimum Educ Level	2004-2014 Growth	2007 Wages	Licensing	Self-Empl
17-3026	Industrial Engineering Technicians	Associate degree	Little or no change	$46,780		.3%

Source: U.S. Department of Labor and America's Career InfoNet (licensing).

Occupational Projections — Pennsylvania

		Employment			Average Annual Openings		
SOC code	Occupation	Est 2004	Proj 2014	Change	Growth	Replace	Total
17-3026	Industrial Engineering Technicians	2,068	2,258	9.2%	19	43	62
	Total	2,068	2,258	9.2%	19	43	62

Source: U.S. Department of Labor

Wage Trends — Pennsylvania

		Median Annual Wage					Change
SOC Code	Occupation	2003	2004	2005	2006	2007	2003 to 2007
17-3026	Industrial Engineering Technicians	$43,500	$42,300	$42,630	$45,940	$46,780	7.5%

Benchmarks for Wage Trends (all occupations)	2003	2004	2005	2006	2007	Change 2003 to 2007
Pennsylvania Median Wage	$27,870	$28,430	$28,800	$29,800	$30,840	10.7%
Pennsylvania Mean Wage	$35,060	$35,780	$36,320	$37,580	$38,960	11.1%
Pennsylvania Mean Wage RSE	0.5%	0.5%	0.4%	0.4%	0.4%	
National Median Wage	$28,140	$28,770	$29,430	$30,400	$31,410	11.6%
National Mean Wage	$36,210	$37,020	$37,870	$39,190	$40,690	12.4%
National Mean Wage RSE	0.2%	0.2%	0.1%	0.1%	0.1%	
National Consumer Price Index (C-CPI-U)	107.8	110.5	113.7	117.0	119.9	11.2%

Note: Relative Standard Error (RSE) is a measure of the reliability of a statistic; the smaller the relative standard error, the more precise the estimate. Source: U.S. Department of Labor

Occupational Employment by Industry (Top 5 Industries) — National

				Occupation Employment			Pct. of Total	
SOC Code	Occupation	NAICS Code	Industry	2006	2016	Change	2006	2016

17-3026	Industrial Engineering Technicians	336400	Aerospace product and parts manufacturing	7,251	8,124	12.0%	9.7%	9.9%
17-3026		334500	Navigational, measuring, electromedical, and control instruments manufacturing	4,266	4,493	5.3%	5.7%	5.5%
17-3026		336300	Motor vehicle parts manufacturing	4,194	3,673	-12.4%	5.6%	4.5%
17-3026		518200	Data processing, hosting, and related services	3,062	4,554	48.7%	4.1%	5.5%
17-3026		325400	Pharmaceutical and medicine manufacturing	2,355	3,265	38.6%	3.1%	4.0%

OSDS Occupational Supply Demand System

Supply Indicators | Demand Indicators | Pennsylvania

Home > Select > MEDICAL EQUIPMENT REPAIR > Demand Indicators

Occupational Characteristics — Pennsylvania

SOC Code	Occupation	Minimum Educ Level	2004-2014 Growth	2007 Wages	Licensing	Self-Empl
49-9062	Medical Equipment Repairers	Associate degree	Little or no change	$41,950		16.2%

Source: U.S. Department of Labor and America's Career InfoNet (licensing).

Occupational Projections — Pennsylvania

		Employment			Average Annual Openings		
SOC code	Occupation	Est 2004	Proj 2014	Change	Growth	Replace	Total
49-9062	Medical Equipment Repairers	763	832	9.0%	7	21	28
	Total	763	832	9.0%	7	21	28

Source: U.S. Department of Labor

Wage Trends — Pennsylvania

		Median Annual Wage					Change
SOC Code	Occupation	2003	2004	2005	2006	2007	2003 to 2007
49-9062	Medical Equipment Repairers	$33,950	$34,460	$38,890	$44,060	$41,950	23.6%

Benchmarks for Wage Trends (all occupations)	2003	2004	2005	2006	2007	Change 2003 to 2007
Pennsylvania Median Wage	$27,870	$28,430	$28,800	$29,800	$30,840	10.7%
Pennsylvania Mean Wage	$35,060	$35,780	$36,320	$37,580	$38,960	11.1%
Pennsylvania Mean Wage RSE	0.5%	0.5%	0.4%	0.4%	0.4%	
National Median Wage	$28,140	$28,770	$29,430	$30,400	$31,410	11.6%
National Mean Wage	$36,210	$37,020	$37,870	$39,190	$40,690	12.4%
National Mean Wage RSE	0.2%	0.2%	0.1%	0.1%	0.1%	
National Consumer Price Index (C-CPI-U)	107.8	110.5	113.7	117.0	119.9	11.2%

Note: Relative Standard Error (RSE) is a measure of the reliability of a statistic; the smaller the relative standard error, the more precise the estimate. Source: U.S. Department of Labor

Occupational Employment by Industry (Top 5 Industries) — National

				Occupation Employment			Pct. of Total	
SOC Code	Occupation	NAICS Code	Industry	2006	2016	Change	2006	2016
49-	Medical Equipment	423400	Professional and commercial equipment and	7,741	10,488	35.5%	20.6%	22.9%

9062	Repairers		supplies merchant wholesalers					
49-9062		622100	General medical and surgical hospitals, public and private	6,321	7,698	21.8%	16.8%	16.8%
49-9062		811200	Electronic and precision equipment repair and maintenance	5,813	5,812	.0%	15.4%	12.7%
49-9062		446100	Health and personal care stores	2,121	2,419	14.0%	5.6%	5.3%
49-9062		532200	Consumer goods rental	1,854	2,218	19.6%	4.9%	4.8%

Appendix C
Related AAS Programs
In Pennsylvania and New Jersey

Two-Year College Programs with Technician Focus	Appl Sci	BioTech	Chem Tech	Electr Tech	Eng Tech	Manuf Tech	Mech Tech	Nanofab
Pennsylvania								
Allegheny (CCAC)				AAS	AAS	AAS	AAS	AAS
Beaver County CC								
Bucks County CC								AAS, Cert
Butler County CC				AAS		AAS		AAS
Central Penn College								
Community College of Phila			AAS					
Delaware County CC				AAS			AAS	AAS
Harcum College								
Harrisburg (HACC)				AAS, Cert			AAS, Cert	AAS
Lackawana County CC		AAS						
Lehigh-Carbon CC	AAS	AAS	AAS	AAS		AAS	AAS	AAS
Luzerne County CC				AAS				AAS
Manor College								
Montgomery County CC		AS, AAS			AAS			
Northampton County CC		AAS	AAS	AAS				AAS
Peirce College								
Penn College Technology				AAS				AAS
Penn Highlands CC		AAS		AAS		AAS, Cert		
Penna Inst Technology							AAS (w/ Nano)	
Reading Area CC							AAS	AAS, Cert
Thaddeus Stevens				AAS			AAS	
Valley Forge Milit Acad								
Westmoreland County CC		AAS (w/Nano)						
New Jersey								
Burlington County College		AAS	AAS	AAS				
Camden County College		AAS			AAS			
Cumberland County College				AAS				
Gloucester County College								

Appendix D
Examples of Possible Certificates of Completion and New Certificate Courses

Biotechnology/Fermentation Certificate of Completion and Relation to AAS Degree

A program has been developed to meet biotechnology industry needs in the area of bioprocessing and fermentation. A strong industry need was also identified in the area of quality control and quality assurance, which is also addressed by the proposed curriculum. The curriculum was developed based on extensive surveys and interviews with individuals working in the biotechnology industry, and participation in the Biotechnology Project of the LSCA, which has involved extensive discussion between industry and academic institutions in the region to define the foundation knowledge and competencies required for someone to enter the biotechnology field as a technician.

For students to receive the Bioprocessing / Fermentation Certificate, they must complete the following seven courses:

- **CHEM 121 College Chemistry I**
- **CHEM 122 College Chemistry II**
- **BIOL 123 Cellular and Molecular Biology**
- **BIOL 211 Genetics**
- **BIOL 241 Principles of Microbiology**
- **BIOL 251 Biotechnology I (2-4-4)** (New Course) This course focuses on foundation knowledge and lab competencies that are critical to success in the biotechnology industry. The ability to carry out lab functions, such as making solutions, performing serial dilutions, making buffers, balancing pH, performing gel electrophoresis, and packing liquid chromatography columns, require that students develop an understanding of the concepts and mathematics involved, as well as demonstrate the competency to carry out these procedures.
- **BIOL 252 Biotechnology II** (2-4-4) (New Course) This course builds on Biotechnology I, and requires students to work in teams to carry out specific biotechnology projects, beginning with a cell culture and ending with the separation and purification of a specific product, such as green fluorescent protein. Students will work in teams in a simulated cGMP environment, and will be expected to follow standard operating procedures (SOPs), document their work, demonstrate aseptic technique and behavior, practice appropriate lab safety, and demonstrate mastery of skills developed in Biotechnology I.

The table below shows how the seven certificate courses could be applied to the proposed AAS degree .

General Requirements	Biotechnology/Fermentation Certificate Requirements	Degree Requirements	Credits
Concentration Courses		**Recommended**	
Chemistry (Chem 110 or higher)	Chem 121 College Chemistry I	Chem 121 College Chemistry I	4
Biology (Biol 106 or higher)	Biol 123 Cellular and Molecular Biology	Biol 123 Cellular and Molecular Biology	4
Physics (Phys 105 or higher)		Phys 105 Survey of Physics (or higher)	4
Lab Science or Applied Science Course	Biol 251 Biotechnology I	Biol 251 Biotechnology I	4
Lab Science or Applied Science Course	Biol 252 Biotechnology II	Biol 252 Biotechnology II	4
Lab Science or Applied Science Course	Biol 241 Principles of Microbiology	Biol 241 Principles of Microbiology	4
Lab Science or Applied Science Course	Biol 211 Genetics	Biol 211 Genetics	4
Internship or Directed Elective	Chem 122 College Chemistry II	Chem 122 College Chemistry II	4
MATH course		Math 118 Intermediate Algebra (or higher)	3
MATH course or ASET 119		Math 150 Introductory Data Analysis or Math 251 Statistics for Science	3
Program Core Courses		Required	
ASET 101 Science, Technology and Public Policy		ASET 101 Science, Technology and Public Policy (New course)	3
ASET 110 Safety, Health and the Environment or ENGR 211 Material, Safety and Equipment Overview for Nanofabrication		ASET 110 Safety, Health and the Environment (New course)	3

ASET 120 Quality Control / Quality Assurance		ASET 120 Quality Control / Quality Assurance (New course)	3
ASET 185 Ethics and Culture of the Applied Sciences Workplace		ASET 185 Ethics and Culture of the Applied Sciences Workplace (New course)	3
General Education Courses		Required	
ENGL 101 English Composition		ENGL 101 English Composition I	3
ENGL 102 English Composition II		ENGL 102 English Composition II	3
CIS 103 PC Applications		CIS 103 PC Applications	3
Humanities Elective		Humanities Elective	3
Social Science Elective		Social Science Elective	3
Total Credits	Certificate: 28	Degree: 63	

Biomedical Technician Training Program Certificate of Completion and Relation to AAS Degree

This program has been offered at the College as a certificate program for a number of years. Based on conversations with the Wistar Institute, our primary partner in this program, it has been determined that establishing a degree program for BTTP would allow for enhanced recruitment into the program. Program changes will be structural, not substantive. Existing BTTP content will be preserved. Specifically, BTT 101 credits will be directly applicable to the proposed AAS degree. In addition, the introductory course (here designated as BTT 100) and the second internship experience (here designated as BTT 201) will be established as credit courses, and will also count toward the degree.

The table below shows how the courses from the BTTP certificate of completion could be applied to the proposed AAS degree .

General Requirements	Certificate Requirements	Degree Requirements	Credits
Concentration Courses		**Recommended**	
Chemistry (Chem 110 or higher)		Chem 121 College Chemistry I	4
Biology (Biol 106 or higher)		Biol 123 Cellular and Molecular Biology	4
Physics (Phys 105 or higher)		Phys 105 Survey of Physics	4
Lab Science or Applied Science Course		Chem 122 College Chemistry II	4
Lab Science or Applied Science Course		Biol 211 Genetics	4
Lab Science or Applied Science Course		Biol 241 Principles of Microbiology	4
Lab Science or Applied Science Course	BTT 100 Introduction to Biomedical Technology	BTT 100 - Introduction to Biomedical Technology	1
Internship or Directed Elective	BTT 101 Biomedical Lab Practicum	BTT 101- Biomedical Lab Practicum	3
Internship or Directed Elective	BTT 201 Biomedical Technology Internship	BTT 201- Biomedical Technology Internship	3
MATH course		Math 118 Intermediate Algebra (or higher)	3

MATH course or ASET 119		Math 150 Introductory Data Analysis or Math 251 Statistics for Science	3
Program Core Courses		Required	
ASET 101 Science, Technology and Public Policy		ASET 101 Science, Technology and Public Policy (New course)	3
ASET 110 Safety, Health and the Environment or ENGR 211 Material, Safety and Equipment Overview for Nanofabrication		ASET 110 Safety, Health and the Environment (New course)	3
ASET 120 Quality Control / Quality Assurance		ASET 120 Quality Control / Quality Assurance (New course)	3
ASET 185 Ethics and Culture of the Applied Sciences Workplace		ASET 185 Ethics and Culture of the Applied Sciences Workplace (New course)	3
General Education Courses		Required	
ENGL 101 English Composition		ENGL 101 English Composition I	3
ENGL 102 English Composition II		ENGL 102 English Composition II	3
CIS 103 PC Applications		CIS 103 PC Applications	3
Humanities Elective		Humanities Elective	3
Social Science Elective		Social Science Elective	3
Total Credits	Certificate: 7	Degree: 64	

Students must complete the following prerequisite courses before beginning the certificate courses: Math 118 (or higher), Chem 110 or 121, Biol 123, Engl 101.

Nanofabrication Manufacturing Technology (NMT) Certificate of Completion and Relation to AAS Degree

The NMT program was previously offered as an Option under Electronics Engineering Technology. The NMT courses that had previously been listed as Electronics courses are currently listed as Engineering courses. Under the proposed degree program, entry to the NMT program would be less reliant on specific electronics content than in the past. This is consistent with changes that have been made to the NMT program in recent years, as Penn State works to keep the program relevant to industry in the face of shifting workforce needs. In fact, NMT programs at other community colleges in Pennsylvania that have been put in place in the last 4-5 years do not include specific electronics courses.

The following table shows how the courses from the NMT certificate of completion can be applied to the proposed AAS degree.

General Requirements	Certificate Requirements	Degree Requirements	Credits
Concentration Courses		**Recommended**	
Chemistry (Chem 110 or higher)		Chem 110	4
Biology (Biol 106 or higher)		Biol 106	4
Physics (Phys 105 or higher)		Phys 105	4
Lab Science or Applied Science Course	ENGR 210 Nanofabrication Manufacturing Technology Seminar	ENGR 210 Nanofabrication Manufacturing Technology Seminar	2
Lab Science or Applied Science Course	ENGR 212 Basic Nanofabrication Processes	ENGR 212 Basic Nanofabrication Processes	3
Lab Science or Applied Science Course	ENGR 213 Thin Films in Nanofabrication	ENGR 213 Thin Films in Nanofabrication	3
Lab Science or Applied Science Course	ENGR 214 Lithography for Nanofabrication	ENGR 214 Lithography for Nanofabrication	3
Lab Science or Applied Science Course	ENGR 215 Materials Modification in Nanofabrication	ENGR 215 Materials Modification in Nanofabrication	3
Internship or Directed Elective	ENGR 216 Characterization, Packaging and Testing of Nanofabrication Structures	ENGR 216 Characterization, Packaging and Testing of Nanofabrication Structures	3

Internship or Directed Elective		Directed Elective	3
MATH course		Math 118 Intermidiate Algebra (or higher)	3
MATH course or ASET 119		Math 150 Introductory Data Analysis or Math 251 Statistics for Science	3
Program Core Courses		Required	
ASET 101 Science, Technology and Public Policy		ASET 101 Science, Technology and Public Policy (New course)	3
ASET 110 Safety, Health and the Environment or ENGR 211 Material, Safety and Equipment Overview for Nanofabrication	ENGR 211 - Material, Safety & Equipment Overview for Nanofabrication	ENGR 211 - Material, Safety & Equipment Overview for Nanofabrication	3
ASET 120 Quality Control / Quality Assurance		ASET 120 Quality Control / Quality Assurance (New course)	3
ASET 185 Ethics and Culture of the Applied Sciences Workplace		ASET 185 Ethics and Culture of the Applied Sciences Workplace (New course)	3
General Education Courses		Required	
ENGL 101 English Composition		ENGL 101 English Composition I	3
ENGL 102 English Composition II		ENGL 102 English Composition II	3
CIS 103 PC Applications		CIS 103 PC Applications	3
Humanities Elective		Humanities Elective	3
Social Science Elective		Social Science Elective	3
Total Credits	Certificate: 20	Degree: 65	

Bionanotechnology Certificate of Completion and Relation to AAS Degree

Bionanotechnology draws on aspects of both biotechnology and nanofabrication. The development of this certificate program was one of the goals of the Nanofabrication Manufacturing Technology (NMT) Seed Grant from Penn State University, namely, to provide students with the necessary skills and educational foundation which are required for employment and retention in the fields of nanotechnology and biotechnology.

Since the NMT Program was established, over 300 Pennsylvania college students have attended the nanotechnology capstone semester at Penn State. Of these, 16 have come from Community College of Philadelphia. The training that these students have received has given them a strong foundation to find employment in a broad range of industries that utilize nanotechnology, including biotechnology. This certificate will be useful to students who are interested in nanotechnology, with a particular emphasis in the biotechnology and pharmaceutical industries.

The Bionanotechnology certificate builds on the Nanofabrication certificate, by requiring four additional courses to the capstone semester. The additional courses (listed below) may be taken before or after the capstone semester at Penn State, with the exception of ENGR 210, which should be taken prior to the capstone semester.

- **BIOL 123 Cellular and Molecular Biology (3-2-4)**. Designed for majors in the sciences and students interested in careers in science and technology, this course is an introduction to the fundamentals of modern cellular and molecular biology.

- **BIOL 251 Biotechnology I (2-4-4)** (New Course) This course focuses on foundation knowledge and lab competencies that are critical to success in the biotechnology industry. The ability to carry out lab functions, such as making solutions, performing serial dilutions, making buffers, balancing pH, performing gel electrophoresis, and packing liquid chromatography columns, require that students develop an understanding of the concepts and mathematics involved, as well as demonstrate the competency to carry out these procedures.

- **CHEM 121 College Chemistry I (3-3-4**). For science, engineering, pre-professional and Chemical Technology students. Atomic structure, classification of matter, chemical and physical properties of the different states of matter, driving forces for chemical reactions, types and geometry of chemical bonds.

- **ENGR 210 Nanofabrication Manufacturing Technology Seminar (2-0-2**). This course gives students an overview of typical nanofabrication applications, and provides an introduction to basic nanofabrication manufacturing technology fabrication process and related terminology, as well as an introduction to basic concepts of statistical process control.

Bionanotechnology certificate courses could be applied to the AAS degree as follows:

General Requirements	Certificate Requirements	Degree Requirements	Credits
Concentration Courses		**Recommended**	
Chemistry (Chem 110 or higher)	Chem 121	Chem 121	4
Biology (Biol 106 or higher)	Biol 123	Biol 123	4
Physics (Phys 105 or higher)		Phys 105	4
Lab Science or Applied Science Course	Biol 251 Biotechnology I	Biol 251 Biotechnology I	4
Lab Science or Applied Science Course	ENGR 210 Nanofabrication Manufacturing Technology Seminar	ENGR 210 Nanofabrication Manufacturing Technology Seminar	2
Lab Science or Applied Science Course	ENGR 212 Basic Nanofabrication Processes	ENGR 212 Basic Nanofabrication Processes	3
Lab Science or Applied Science Course	ENGR 213 Thin Films in Nanofabrication	ENGR 213 Thin Films in Nanofabrication	3
Lab Science or Applied Science Course	ENGR 214 Lithography for Nanofabrication	ENGR 214 Lithography for Nanofabrication	3
Internship or Directed Elective	ENGR 215 Materials Modification in Nanofabrication	ENGR 215 Materials Modification in Nanofabrication	3
Internship or Directed Elective	ENGR 216 Characterization, Packaging and Testing of Nanofabrication Structures	ENGR 216 Characterization, Packaging and Testing of Nanofabrication Structures	3
MATH course		Math 118 Intermediate Algebra (or higher)	3
MATH course or ASET 119		Math 150 Introductory Data Analysis or Math 251 Statistics for Science	3
Program Core Courses		Required	
ASET 101 Science, Technology and Public Policy		ASET 101 Science, Technology and Public Policy (New course)	3
ASET 110 Safety, Health and the Environment or ENGR 211 Material, Safety and Equipment	ENGR 211 Material, Safety & Equipment Overview for Nanofabrication	ENGR 211 - Material, Safety & Equipment Overview for Nanofabrication	3

Overview for Nanofabrication			
ASET 120 Quality Control / Quality Assurance		ASET 120 Quality Control / Quality Assurance (New course)	3
ASET 185 Ethics and Culture of the Applied Sciences Workplace		ASET 185 Ethics and Culture of the Applied Sciences Workplace (New course)	3
General Education Courses		Required	
ENGL 101 English Composition		ENGL 101 English Composition I	3
ENGL 102 English Composition II		ENGL 102 English Composition II	3
CIS 103 PC Applications		CIS 103 PC Applications	3
Humanities Elective		Humanities Elective	3
Social Science Elective		Social Science Elective	3
Total Credits	Certificate: 32	Degree: 66	

Process Technology Certificates of Completion and Relation to AAS Degree

The curriculum for this program is based on a national model, developed by the Center for the Advancement of Process Technology (CAPT), an NSF supported center that supports the development of a highly skilled, educated and diverse process technician workforce for the chemical manufacturing, refining, oil and gas production, and pharmaceutical manufacturing industry sectors. They are also expanding to other areas, such a food processing.

The CAPT curriculum was adapted by Delaware County Community College (DCCC) to address the needs of companies in our region. DCCC has reviewed the curriculum with local industry to ensure that students completing the program would be employable. Sunoco, in particular, has been a significant industry partner.

Process Technology actually consists of two certificates: a basic "Certificate of Competency"; and a "Certificate of Proficiency" that builds on the first certificate.

The Certificate of Competency consists of three Process Technology courses, along with three foundation courses. The three Process Technology courses, as well as the three foundation courses, can be applied to the AAS in Applied Science and Engineering Technology. The Certificate of Competency courses include the following:

- **CIS 103 PC Applications**
- **MATH 118 Intermediate Algebra**
- **CHEM 110 Introduction to Chemistry**
- **PTEC 101 Introduction to Process Technology** (2-2-3) (New Course) This course provides an overview of the concepts associated with Process Technology as well as an introduction to the role of Process Operators and Process Control Technicians as part of a team in the production environment. The course also provides a basic overview of issues and sciences associated with the refining and production of chemicals.
- **PTEC 102 Plant Equipment** (2-1-2) (New Course) This course provides an introduction to basic hand tools as well as a study of industrial plant equipment. Topics of study include equipment construction, principles of operation, care, maintenance and utilization.
- **ASET 110 Safety, Health and the Environment** (3-0-3) (New Course) This course provides students with an overview of potential industry/product and facility hazards that may be arise in an industrial setting, as well as the types of engineering controls, administrative controls, personal protective equipment, and current safety, health and

environmental regulations that affect these industries. In addition, the course will include current safety health and environmental regulations, standards, and laws.

The Certificate of Proficiency requires three additional Process Technology courses, as well as a course in Quality Control and a course in Fluid Power and Controls. ASET 119 and PHYS 105 are also required for the Certificate. Proficiency courses are as follows:

- **PHYS 105 Survey of Physics**

- **ASET 119 Problem Solving for Technology** (3-0-3) (New Course) This course will be modeled after Electronics 119 (no longer an active course), and will provide students with an understanding of problem-solving methods utilizing mathematical tools. Applications of algebra, logarithmic and exponential functions, and well as trigonometric functions, to the solution of technology-related problems, will be emphasized.

- **PTEC 111 Process Control I** (3-1-3) (New Course) This course provides students with an introduction to the basic operating principles of process control systems. Topics of study will include control principles, the elements of process control systems, and process control signals and systems. The course also provides for an introductory study of various input and output devices used to control process variables in such industries as petroleum, petrochemical, chemical, pharmaceutical, and food processing.

- **PTEC 115 Process Control II** (3-1-3) (New Course) This course builds on Process Control I and presents additional theory and applications of process control. Integrated topics such as control loops and variable measurements will be presented. Additionally, topics to be studied will include, but not be limited to: conductivity, pH, optical measurements, products of combustion, and chromatography. Process control computers, distributed control systems, and system integration will also be discussed in detail.

- **PTEC 120 Unit Operations** (3-1-3) (New Course) This course provides students with an opportunity to integrate learning from previous courses and to synthesize an overall understanding of production processes. Students will gain an understanding of how principles of fluid mechanics, heat transfer and mass transfer are coordinated in an actual production process.

- **ASET 120 Quality Assurance/Quality Contro**l (3-0-3) This is a required course for the AAS curriculum and is described in Section VI, Proposed Courses, above.

- **PTEC 125 Fluid Power and Controls** (3-2-4) (New Course) This course provides a study of the basic principles of industrial fluid mechanics, hydraulics, and pneumatics. Types of fluid, their condition and use in transmitting power throughout various fluidic circuits are addressed, along with circuit components such as pumps, compressors and conductors. Characteristics such as flow, pressure/vacuum, force,

temperature, torque, speed, power, and efficiency, as well as component and circuit performance will also be addressed. Instructional emphasis is placed on the relevant theoretical and practical aspects of the subject.

- **ASET 185 Ethics and Culture of the Applied Sciences Workplace** (3-0-3) This is a required course for the AAS curriculum and is described in Section VI, Proposed Courses, above.

General Requirements	**Certificate Requirements**		**Degree Requirements**	**Credits**
Concentration Courses	**Competency**	**Proficiency**	**Recommended**	
Chemistry (Chem 110 or higher)	Chem 110		Chem 110	4
Biology (Biol 106 or higher)			Biol 106	4
Physics (Phys 105 or higher)		Phys 105	Phys 105	4
Lab Science or Applied Science Course	PTEC 101 Introduction to Process Control		PTEC 101: Introduction to Process Control	3
Lab Science or Applied Science Course	PTEC 102 Plant Equipment		PTEC 102: Plant Equipment	2
Lab Science or Applied Science Course		PTEC 111 Process Control I	PTEC 111: Process Control I	3
Lab Science or Applied Science Course		PTEC 115 Process Control II	PTEC 115: Process Control II	3
Internship or Directed Elective		PTEC 125 Fluid Power and Controls	PTEC 125 Fluid Power and Controls	4
Internship or Directed Elective		PTEC 120: Unit Operations	PTEC 120: Unit Operations	3
MATH course	Math 118		Math 118 (or higher)	3
MATH course or ASET 119		ASET 119: Problem Solving for Technology	ASET 119: Problem Solving for Technology	3
Program Core Courses			Required	
ASET 101 Science, Technology and Public Policy			ASET 101 Science, Technology and Public Policy (New course)	3
ASET 110 Safety,	ASET 110		ASET 110 Safety, Health and	3

Health and the Environment or ENGR 211 Material, Safety and Equipment Overview for Nanofabrication			the Environment (New course)	
ASET 120 Quality Control / Quality Assurance		ASET 120 Quality Control / Quality Assurance	ASET 120 Quality Control / Quality Assurance (New course)	3
ASET 185 Ethics and Culture of the Applied Sciences Workplace		ASET 185 Ethics and Culture of the Applied Sciences Workplace	ASET 185 Ethics and Culture of the Applied Sciences Workplace (New course)	3
General Education Courses			Required	
ENGL 101 English Composition I		ENGL 101 English Composition I	ENGL 101 English Composition I	3
ENGL 102 English Composition II			ENGL 102 English Composition II	3
CIS 103 PC Applications	CIS 103 PC Applications		CIS 103 PC Applications	3
Humanities Elective			Humanities Elective	3
Social Science Elective			Social Science Elective	3
Total Credits	Competency: 18	Proficiency: 29	Degree: 63	